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CONTENTS

Agricultural Education in Western Australia.....Report of the Western Australian Branch 1

Agricultural Education in England and Wales..... 6

The Australian Food Position.....by E. T. Edwards 13

Surveys of Potential Land Use.....by J. K. Taylor 20

Summer-Rainfall Pastures and the Cattle Industries.....by C. S. Christian 25

Production Cost Studies as a Field of Research in Agricultural Economics.....by K. O. Campbell 31

Technical Note—

The Effect of the Host Fruit upon the Scale *Aonidiella aurantii* Mask. in Relation to its Parasite *Comperiella bifasciata* How.....by Hubert W. Simmonds 38

The Australian Institute of Agricultural Science..... 39

Correspondence..... 41

Book Review..... 42

Current Notes and News..... 43

Obituary: Henry Tryon..... 44

Personal Notes..... 44

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The Journal of

THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE

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VOL. 10, No. 1 MARCH, 1944

Agricultural Education in Western Australia

REPORT OF THE WESTERN AUSTRALIAN BRANCH

Any scheme for post-war rural reconstruction must give due consideration to agricultural education in all its phases. The prime aim of education is to fit persons to make a living and to take an intelligent interest in community well-being and progress. With this in mind, the Western Australian Branch of the Institute submitted to the Rural Reconstruction Commission in October, 1943, the following review of educational facilities for the rural population in Western Australia, with suggestions for modification and improvement. This report has been prepared by a sub-committee appointed for the purpose after the subject had been discussed at a general meeting of the Branch and it represents the opinions of the Branch. The sub-committee comprised Mr. W. P. Cass Smith (Branch President), Professor G. A. Currie and Mr. G. H. Burvill.

The aspects of agricultural advisory or extension services receive most detailed consideration, since the majority of Branch members are engaged in the fields of agricultural research and the transmission of the results of such investigations to farmers through advisory channels.

Education.

Primary Education.

Country children as compared with those from the city, are favoured in their upbringing by a wide range of experience with animals, birds and nature generally, also with machines and manual tasks. To this practical education which country children gain as a natural part of their life must be joined a good general education, but in small rural schools they suffer disadvantages which may be remedied by the establishment, wherever possible, of " area " schools. Modern transport and good roads will allow children within a 20-30 mile radius to be brought together in larger schools to receive the benefits of better social training and of teaching by more highly qualified staff. Headmasters and teachers of such " area " schools would be provided with a sound background of knowledge if they undertook the University Degree course in Agricultural Science. Apparently the present system of training and promotion of teachers does not attract agricultural graduates to rural school work.

To develop powers of critical observation among children, nature study is an excellent subject. School gardens for demonstrations as an adjunct to nature study should be encouraged.

Post-Primary Education (11+ *years*).

The Narrogin School of Agriculture since 1914 and more recently the Denmark Farm School, have offered primary and vocational training for boys desiring to remain on the land. There is scope in Western Australia for more schools of this type, devoting attention to the techniques of agriculture rather than to theory and professional aspects, and at the same time providing facilities and teaching for those who wish to attempt the University Junior Certificate examination.

For these schools it is desirable that an agricultural graduate teacher should be in charge, while the general farming activities should be supervised by a diploma holder from an Agricultural College.

Boys of 12-16 years are generally very useful on their parents' farms, so that to encourage post-primary vocational training, a system of scholarships or financial aid may be necessary to offset the loss of help while boys are away from home.

Secondary Education (12-17 *years*).

Secondary education should be as freely available to country children as to those of towns ; and with State High Schools at Northam, Kalgoorlie, Geraldton, Bunbury and Albany, reasonable provision is made. On the agricultural side, one agricultural college at present appears sufficient, and this exists at Muresk. However, financial difficulties have undoubtedly restricted attendances at this college in the past, and the provision of more scholarships, or similar encouragement, is urgently required if in future more youths are to avail themselves of an agricultural college training as a basis for farm careers.

The agricultural college should provide education in the advanced theory and techniques of farming, and should aim to train highly skilled farmers as well as some students who will continue with University courses. Fullest use should be made of the trained staff and facilities, plant and stock at an agricultural college by conducting short courses for farmers in special subjects, e.g. pigs, sheep, woolclassing.

University Courses.

The Degree course in the Faculty of Agriculture of the University of Western Australia provides scientific training for persons taking up professional work in agriculture. The course has been modified in various directions in recent years to keep pace with modern agricultural trends. The soundness of the agricultural degree course may be gauged from the general success of the graduates, of whom about half are employed by the Western Australian Department of Agriculture on research and advisory work, while a number more are employed by the Council for Scientific and Industrial Research in various parts of Australia. Evidence of practical training in farming techniques is required from students. This experience has been gained on private farms, agricultural research stations, and at Muresk Agricultural College and the aim at present is to diversify the practical training as much as possible.

Agricultural Extension and Advisory Services.

Agricultural extension or advisory work is the most important phase of adult education in rural areas. In Western Australia it is largely performed by the Department of Agriculture through its district advisers and specialist head-office staff. Personal contact and correspondence are supplemented by the quarterly publication of the Journal of the Department of Agriculture (3,000 copies) and the issue of leaflets and bulletins, most of which are available free to bona fide farmers. Press paragraphs on current agricultural topics are supplied to the metropolitan and country Press and radio talks on special and general topics are prepared by Departmental officers and the staff of the University Faculty of Agriculture.

In addition, the Agricultural Bank, private trading banks, stock, machinery, seed and fertilizer firms assist with extension to a limited degree through their inspectors and field officers, and by republication of agricultural articles in their trade papers.

The Royal Agricultural Society and district Agricultural Societies, through their shows and in their sponsoring of crop and other farm competitions, also serve to extend knowledge and encourage progress among farmers.

Advisory Officers.

In Western Australia extension officers are termed agricultural advisers, horticultural advisers and instructors, dairy advisers and instructors, etc. For advice on stock diseases, veterinary surgeons are employed. A number of such men are stationed at key centres, but many have been compelled to cover too large a territory, so that contact with many farmers has been infrequent. This has resulted in a feeling among agricultural research workers that their efforts, while pointing the way to progress, are not used to best advantage. On this aspect, the Western Australian Branch of the Institute of Agricultural Science passed the following motion :

> That this Branch believes that an efficient application of the knowledge obtained from scientific research can only be brought about by the employment of an increased number of trained extension workers and by an improvement of their conditions, particularly with reference to opportunities for exchange between the States, and possibly abroad, with the provision of regular " refresher " study courses, and with participation in, and active contact with the activities of research workers. Such contacts would prove mutually beneficial to the research men as well as to the extension workers.

The numbers, distribution and academic training of the advisory staff of the Western Australian Department of Agriculture are shown in Table 1. Of the 51 university graduates shown in the table, 34 are graduates in agriculture from the University of Western Australia ; 10 have veterinary degrees or diplomas ; 3 are science graduates and 1 is an arts graduate of Western Australia, and 3 have degrees or diplomas from British universities.

A large number of the Western Australian agricultural graduates joined the Department of Agriculture as cadets while taking the degree course. Such a cadetship system is to be commended, for, while they are students at the University, cadets obtain a varied training in several branches of the Department of Agriculture. This provides a sounder background of experience both during the student period and subsequently when they are engaged on either extension or research work.

There is need for a big increase in the numbers on district advisory work to spread new knowledge and to act as a pulse for rural problems. The personnel must, however, be well trained and fitted to the task. The prerequisites of a good extension officer are a sound fundamental training in the theory and practice of agriculture, coupled with good personality and the ability and facilities to impart knowledge by all modern methods—the spoken and written word, and visually through films and slides.

It is considered that the University degree course in agriculture gives the fundamental theoretical knowledge required by district advisory officers. District work has not, however, proved very attractive to University graduates in agriculture for various reasons. Isolation from other professional workers, inferior living conditions and, until recent years, low salaries, have detracted from such posts. Through lack of positions in Western Australia, or the attraction of better salaries and conditions offered by C.S.I.R. and other States, 19 Western Australian graduates in agriculture have, since 1928, gone to employment by C.S.I.R. or the Waite Institute

or Departments of Agriculture in other States. Of these only two are now working in Western Australia. Nine were formerly officers of the Western Australian Department of Agriculture.

TABLE 1.

Distribution and Training of the Advisory Staff of the Department of Agriculture of Western Australia.

Branch of Department and/or Rural Industry.	Stationed in Perth, on Research and/or Advisory Work.		Stationed in Country Districts on Advisory Work.			Approximate No. of farms where such Industry is an Important Activity.	Farms per Country or District Adviser.[1]
	University Graduates[2]	Non-Graduates[3]	University Graduates[2]	Non-Graduates[3]	Total.		
Under Secretary	1	—	—	—	—	—	—
Wheat	6	1	5	5	10	8,000	900
Sheep and Wool	—	1	—	—	—	9,000	
Dairying	3	—	2	5	7	3,500	500
Fruit	3	1	1	8	9	3,000	333
Potatoes and Vegetables	1	2	—	1	1	3,000	750[4]
Poultry	—	2	—	—	—	2,000	1,000[4]
Apiculture	—	1	—	—	—	100[5]	100[4]
Irrigation	—	1	4	1	5	—	—
Tobacco	—	—	2	—	2	100	50
Stock (veterinary)	7	1	5	3	8	—	—
Botany, agrostology, plant pathology, entomology, soils, and plant nutrition	11	1	—	—	—	—	—
Totals	32	11	19	23	42	Total rural holdings : 18,000	
	43		42				

[1] There is considerable overlapping of industries on mixed farms. Most wheat farms carry sheep and the advisory services are largely combined. Many holdings combine dairying, fruit and/or potatoes and vegetables, but advisory services are more distinct.

[2] The University graduates include holders of agricultural and veterinary diplomas.

[3] Includes 6 farm managers on research stations, 3 potato inspectors and 4 stock inspectors, but not officers engaged on purely inspectional work.

[4] In the case of potatoes and vegetables, poultry and apiculture, officers stationed in Perth are district advisers.

[5] These 100 apiarists are likely to produce upwards of 400 gallons of honey each per annum. Actually there are 2,750 registered beekeepers.

By suitable inducements, good men (and women) should be encouraged to remain in Western Australia to expand the trained district advisory staff. Points for consideration are as follows :

(*a*) Along with country people in general, advisers usually find that they have to accept housing and facilities of a much lower standard than can be enjoyed in the Perth metropolitan area. Either financial compensation or a government housing scheme should be instituted to offset this handicap.

(*b*) Advisers should make contact whenever possible with research workers and should be encouraged to undertake and share field research projects in their districts.

(*c*) Advisers should also be encouraged to play an active part in all matters of rural interest, so that they will have added standing in the community which they serve. They should maintain contact with representatives of firms and institutions which provide financial backing, since financial restrictions often prevent even competent farmers from following recommended practices.

(*d*) Refresher courses should be provided for advisers at least annually to break down feelings of isolation, to hear from specialist and research officers about recent developments and findings and to discuss their implications in practice.

(*e*) Library. Literature from the central library of the Department of Agriculture should be circulated freely to officers in the country to keep interest keen and knowledge up to date.

(*f*) Travel. Just as frequently as finances can be arranged, extension officers, who do not normally get opportunities of foreign or interstate travel, should be given leave and expenses to see other areas. Such " refresher " sabbatical leaves would help to prevent stagnation and give new ideas of value to the Department and to the districts from which the officer goes.

Organization of Extension Work.

No separate extension or information branch exists in the Western Australian Department of Agriculture. Agricultural and other advisers and instructors are attached to various branches of the Department such as Wheat, Dairying and Horticulture, and are stationed in districts where those are major phases of agriculture. Library supervision and editorial work for the Journal of the Department of Agriculture are performed on a part-time basis by clerical staff who have no special training for the task.

Likewise, personal public enquiries in the head office are not received and directed to the proper channels by an officer widely versed in agriculture. In some respects this set-up is obviously opposed to high efficiency in extension of new knowledge to farmers. Research is the life blood of agricultural progress but its results must be presented to the farmer in practical terms. There is scope in the Department of Agriculture for a small group of officers with the following functions :

(*a*) To organize and control the library and see that literature arriving from other states and abroad reaches the appropriate administrative, research, and advisory officers.

(*b*) To edit and produce the Journal of the Department of Agriculture, also leaflets and pamphlets. If the Journal is primarily an extension medium, the presentation of articles should keep abreast of modern journalistic practice.

(*c*) To regularly contact officers in various branches of the Department to learn of the latest problems and developments and advise extension officers, particularly district advisory officers, on these matters by means of a monthly circular.

(*d*) To receive personal enquiries from members of the public and direct these where necessary to the appropriate branch of the Department.

(*e*) To organize series of broadcast talks on special and general agricultural topics.

Junior Farmers' Clubs, Rural Libraries and Summer Schools.

These are phases of adult education in rural communities which should be encouraged and expanded. Junior Farmers' Clubs require the help of the district agricultural adviser, and he should join forces with the local school teacher to make sure that scholars just leaving school have an opportunity to join agricultural classes, clubs, study groups and so on. They form a training ground in civics and for local government positions as well as for the advancement of agriculture.

Agricultural Education in England and Wales.

Résumé of the Report of a Committee on Post-War Agricultural Education in England and Wales. The Report was presented to Parliament by the Minister of Agriculture and Fisheries, April, 1943. This résumé was prepared by Mr. E. Breakwell, B.A., B.Sc., Inspector of School Agriculture, N.S.W. Department of Education, Sydney.

This British report consists of five sections, namely, the present position of agricultural education, a criticism of the system, proposals for a reorganized system, proposals in connection with specialized branches and a summary of the recommendations. In this résumé the report of the Committee is discussed under three main headings, viz. survey of the present position, criticism and recommendations, and the main features of the recommendations.

SURVEY OF PRESENT POSITION.

Elementary and Secondary Education.

The present position of elementary and secondary education is that it is compulsory from 5 to 14 years of age. Although the leaving age has been raised to 15, this has not yet come into effect, owing to the war. There are three types of schools, viz. elementary, secondary and junior technical schools.

Elementary.—In elementary schools, pupils carry on until 14 or 15 years of age. A selection, however, is made at 11 years of age for (*a*) senior schools, sometimes called non-selective central, or modern schools, and (*b*) secondary schools of academic type. At the present time 63·15 per cent. of all pupils in England and Wales over 11 years of age belong to senior schools. These schools have to be specially equipped for teaching general science but at the present time only one-third of the schools in rural areas are so organized. However, in the non-organized schools the pupils over 11 years of age take the same course as those in senior schools.

Secondary.—Secondary schools cater for pupils of specific ability, who profit by a more academic type of education than that given at the senior schools. They take the school certificate examination at 15 or 16 and the higher school certificate at 18. Only 10 per cent. go to Universities or Teachers' Colleges.

Junior Technical Schools.—Junior Technical Schools prepare pupils for entry to either specific industries or groups of industries without restrictions to particular trades within those industries (e.g. engineering, building or mining industries) or commercial life. Pupils are drafted into these schools from elementary schools at 13 or 14 years of age. Agriculture is not taught in such schools at the present time.

Teaching of Agriculture.—Agriculture is not taught as a vocational subject before the age of 15. In the senior schools, a school garden is an essential feature of school life and provides the background for much of the science course. In addition, the pupils of those schools are encouraged to keep small livestock such as poultry, bees and rabbits. Sometimes they form Young Farmers' Clubs in connection with these activities. In these schools the older method of teaching science as so many separate subjects, for example chemistry, physics and botany, has been discarded, and teaching on broader lines substituted.

In urban districts senior schools have, wherever possible, gardens which are used in much the same way as in the country schools. But generally speaking, these schools do not use their gardens to the best advantage in their indoor teaching. They still tend to draw most of their illustrations from the things commonly observed in the town and to pay little attention to things of the countryside, a knowledge of which is fundamental to a sound general education and a full and healthy life.

Comparison with the System in N.S.W.—The senior schools can be compared with our District Rural Schools and some of our Intermediate High Schools. The percentage of such schools in this State is much smaller, and specialized, rather than general, science courses are followed. Our pupils commence this secondary course at 12 years of age instead of at 11 years, as in England. Where agriculture is taught all schools have a farm attached. Most pupils belong to Young Farmers' Clubs, as in England. In the third or Intermediate year, when the pupils are a year older than those in the third year of the British senior schools, major agricultural operations such as ploughing, drilling and cultivating are carried out.

Agricultural Education beyond Senior School Stage.—This is of two types, namely institutional and non-institutional.

Institutional Agricultural Education.

Institutional agricultural education is carried out at thirteen farm institutes, seven agricultural colleges, seven universities and at individual institutions.

Farm Institutes.—In September, 1939, the number of pupils in attendance varied from 18 to 105. Both sexes were enrolled and previous practical experience was necessary. Courses covered a full academic year with three terms. The main course was general agriculture, including dairy and poultry husbandry. In addition there were specialized courses in dairying, poultry-keeping and horticulture. Shorter courses were also arranged. Students were examined and certificates granted. The County Organizer (Advisory Service) was the Principal of the Farm Institute, and he usually carried out the dual rôle of teaching his students and giving advice to neighbouring farmers. Some Farm Institutes had two-year courses, and prepared pupils for National Diplomas in Agriculture, Poultry Husbandry and Dairying.

Agricultural Colleges.—The Committee found that the courses at agricultural colleges varied considerably in content and duration. The main course usually extended over a period of two years and subjects taught were general agriculture, horticulture, dairying and poultry-keeping. Courses in forestry and estate management existed at two colleges. Students could not enter before 16 years of age and must have an educational standard equivalent to the holding of a school certificate. At the end of two years diplomas were granted.

Comparison with N.S.W.—Farm Institutes might be compared with our Experiment Farms and Agricultural Colleges to Hawkesbury Agricultural College, or the fourth and fifth years of our Agricultural High Schools. The entrance requirements in England are higher than in this State, their School Certificate standard being more advanced than our Intermediate Certificate.

Universities.—The Committee found that the Universities generally provided a course leading to a degree, but some provided courses in one or more of the specialized subjects which led to degrees. For example, Cambridge had a three-years' course, leading to a pass degree in agriculture and estate management. London had a three-years' course leading to a B.Sc.Agr., B.Sc. Horticulture and a B.Sc. Estate Management.

Most of the Universities provided courses leading to diplomas, which were of two kinds, viz. (*a*) graduate diplomas for candidates already possessing degrees, and (*b*) initial diplomas of a lower standing than a degree. Cambridge provided a one-year's course for graduate diplomas in specialized science ; Oxford a one-year course leading to a diploma in rural economy, which may be taken in one of three selected subjects, e.g. agricultural economics, agricultural engineering and statistical method.

Most Universities provide two degrees—an Honours degree and a Pass degree. The Honours degree entailed a wider study of fundamental sciences underlying agriculture, and a specialization in the first year, in some branch of agricultural science, e.g. agricultural chemistry or agricultural botany. The teaching at the University was always associated with a farm, but this was usually not available for

the teaching of actual farming operations and, except in the case of Leeds University, there was no practical training at all.

Non-Institutional Agricultural Education.

Non-institutional agricultural education consisted of the advisory services, instructional classes, correspondence courses, lectures, demonstrations, discussion groups and associations.

Advisory Services.—These embraced general and specialized advisory services.

General advice was given by the County Organizer and his staff, with the Farm Institute, if one existed, as the centre. The County Organizer (usually the Principal of the Institute) dealt with farming practice, dairy husbandry, poultry husbandry and the like. Administrative duties, such as the policing of injurious weeds, land drainage, etc., were also carried out. Since the outbreak of war the Ministry of Agriculture set up War Agricultural Committees and in such cases the County Organizer and his staff played a most important part in the operations of such committees.

Specialized advice was given by the Provincial Advisory Service. There were thirteen provinces, and the specialists were provided by the University or Agricultural College. Special advice was given in chemistry, dairy bacteriology, economics, entomology, mycology and veterinary science. The specialist officers were under the general direction of the Professor of Agriculture, or the Principal of the College. Local investigations and research work were also carried out.

Specialist officers were not expected to act except at the request of the General Advisory Service, but they often received requests from farmers direct. In some cases the County Organizers were informed of the replies given, but in other cases the enquiries were referred to the County Organizer. Periodic conferences, to discuss co-ordination, were held.

Instructional Classes.—These were classified under the following headings: (1) organized day classes; (2) evening classes; (3) instructions in agricultural manual processes. (1) and (2) were arranged by the local authorities under the direction of the County Organizer and were mainly designed for those engaged in farming. (3) consisted of short courses in ploughing, hedge-making, ditching, thatching, milking, sheep-shearing, etc. Correspondence courses, lectures, demonstrations and discussion groups were also carried out. Evening classes proved the most popular. In 1921-22 there were 5,402 students and in 1929, 13,101 students.

Young Farmers' Clubs.—Particular emphasis is placed on the value of Young Farmers' Clubs. These clubs have had three reorganizations in their history, namely in 1924, in 1928 and in 1932, when the National Federation of Young Farmers' Clubs was founded. Owing to its outstanding success a suitable sum has been placed at the disposal of the National Federation during the war by the Ministry of Agriculture and the Board of Education to enable it to extend its activities generally and to fulfil its functions as an integral part of the service of youth.

Control and Finance of Agricultural Education.

The Board of Education controls agricultural education in senior schools up to the age of 15 and in continuation schools at ages between 15 to 18. Farm Institutes, Agricultural Colleges and Advisory Services are controlled by the Ministry of Agriculture. The Board of Education, however, cooperates in the inspectorate division. The financial liability of carrying on Farm Institutes falls in the first place on the county council concerned, but the Ministry of Agriculture assists the county council by providing a percentage of its approved expenditure. The Ministry also makes grants to universities and agricultural colleges to assist them in the annual costs of their educational activities in connection with agriculture. The assistance rendered to the County Advisory Service is on a 60 per cent. basis.

CRITICISMS AND RECOMMENDATIONS.

Elementary and Secondary Education.

The committee recommends the continuation of the senior school system and an extended education for students of 14 or 15 years of age. Emphasis is placed on the value of general science. The committee points out that the number of candidates offering general science in the Cambridge School Certificate Examination has increased 25 per cent. in five years and in the Northern Universities Matriculation Board has increased from 300 students to 3,700 students in the same period. Biology shows a corresponding increase. The number of students taking physics and chemistry has considerably declined in that period. The committee considers that the teaching of science in relation to the principles underlying the work and life of the countryside should be carried out in urban as well as in rural areas. Every citizen should be familiar with the broad scientific principles relating to the production, handling and use of the various common articles of food to be seen on his table from day to day. The committee recommends an appropriate training of more science teachers for the teaching of biology and general science.

Vocational Training in Agriculture.—It is considered there should be no attempt at any form of vocational training for children below the age of 15. It recommends, however, a school garden for the study of the essential sciences and also favours the formation of Young Farmers' Clubs in senior schools, 135 of which are already in operation at such schools. It also recommends the development of camp schools for students from urban areas. It recommends that pupils should graduate in general agriculture or in one or other of the sciences connected with it.

Secondary Schools of Academic Type.—The committee emphasizes the substantial increase in the teaching of the principles of biology and the consequent improvement in the science teaching as a cultural background, as well as a basis for the subsequent agricultural education of those desiring to enter the industry. Although vocational instruction in agriculture is better provided at a farm institute the committee considers that where farms have been established at secondary schools they can be used as a background for some of the science teaching.

Institutional Education.

Farm Institutes.—The committee recognizes the good work carried out by the Institutes, but criticizes the lack of standardization. Some of the institutes had a gloomy and depressing appearance, while others displayed extravagance in the cost of construction. They also offered too many specialized courses. They should provide a course in general agriculture extending over a period of one year ; and the unit should be between 60 and 70 students for an Institute. Short courses could be introduced, and the staff should be trained in teaching and lecturing.

It is not desirable that the County Organizer should be the Principal of the Farm Institute. The teachers in Farm Institutes should receive specific training in teaching methods. Entrance of students should be at 18, and the Institute should be used to train farmers, farm managers, bailiffs. The course should not be too scientific, but could be preparatory to other courses when required.

Agricultural Colleges.—These have always taught agriculture against an agricultural background and have always possessed good farming facilities (a feature lacking in the case of the Universities). Competition with Universities, however, has affected their status and progress because (*a*) entrants to the Public Service have found a degree essential, (*b*) some Universities offer diploma courses which should be regarded as the special function of the College.

Colleges have endeavoured to meet the situation by offering a number of courses ; some of these compete with those at the Farm Institute, while others prepare students for the external degree of London University. There is often a multiplicity of

long and short courses in both agriculture and its specialized branches without any defined position in the general scheme of agricultural education. There is no uniformity of standard between the diplomas awarded by different colleges.

The committee considers that there is a place for the Agricultural College between the Farm Institute and the University. It should offer courses in the specialized branches of the industry, but these courses should, except in the case of horticulture, be appendant to a general course in agriculture. They should not exceed one year and no college should offer more than one, or at the most two, specialized courses.

The College should be the first to develop and incorporate improvements in agricultural practice.

Universities.—The committee considers that a University should not provide courses leading to a diploma or a certificate below degree standard. University courses are best adapted to the study of the basic sciences or of general agriculture and they should not give degrees in dairying or poultry. Graduate diploma courses in specialized branches should, however, be allowed.

The committee recommends two types of courses :

(*a*) The practical type for large farmers, land owners, estate managers and land agents, and

(*b*) academic type for teachers, advisory officers, research workers and other specialists.

The practical type should combine agriculture and the allied sciences throughout the course. Its objectives should be (*a*) to give knowledge of British agriculture and to promote thought on it by providing agricultural education on a wide scientific basis, (*b*) to impart appropriate knowledge of the sciences, of their agricultural applications, and of the biologic and economic factors by which agricultural policy and practice are determined, and (*c*) to give such knowledge of British agricultural practice, based on principles, as is required for an understanding of the application of the sciences to agriculture and as a preparation for farming and related activities.

The academic type should be provided by an honours course in some branch of the natural sciences followed by a graduate course in agriculture or agricultural science. The objective of the graduate course should be to give (*a*) a knowledge of the special technique and developments of the science concerned which lie outside the scope of the cognate pure science, (*b*) an advanced knowledge of the pure science concerned, (*c*) a grasp of the principles of experimentation including statistical analysis, (*d*) a general knowledge of agriculture in both its scientific and practical aspects. The specialized scientist can never equal the farmer or husbandry specialist in practical knowledge, but he must be able to grasp practical aspects clearly, and to turn science to practical account.

The need of a practical training in the university course is emphasized.

Non-institutional Education.

County Advisory Service.—In many cases the farmers have refused to recognize the value of scientific knowledge to agricultural practice, but War Agricultural Executive Committees have considerably modified this conservatism. The Committee considers that the County Organizer has insufficient staff and that his duties are too administrative. In many cases he has failed to make sufficient use of the Provincial Advisory Service (specialized branch). This is due in some cases to unwillingness to admit incompetence, in others to under-estimation of the difficulty of the problem.

Provincial Advisory Service.—The Committee found a distinct lack of co-ordination between the Provincial (specialist) and County (general) Advisory Services. In some cases, farmers were unaware of the existence of the Provincial Advisory

Service. A considerable amount of overlapping and friction undoubtedly existed between the two services. Other dangers were (*a*) lack of co-ordination between the advisory officers of the province, (*b*) lack of contact at agricultural colleges between the advisory officers and scientific workers, (*c*) the danger at Universities of divided loyalties to, and interest in, the work of the University and of the Advisory Service, (*d*) lack of sufficient acquaintance with farming practice ; especially in the case of the chemist specialist. There also appeared to be no definite channel whereby the results of research work done by advisory officers of the research institute could be transmitted to the farmer, nor any provision whereby the problems of general importance could be passed on to research institutes for further investigation.

Continuation and Instruction Classes.—The Committee considered that all the activities carried out by instructional classes, lectures, demonstrations, etc., had been of considerable benefit. There is criticism on (*a*) lack of co-ordination, and (*b*) lack of training in teaching methods.

Continuation courses are strongly recommended for students of from 15 to 18 years of age. They should be planned to provide cultural and vocational education. The cultural should be the same for all vocations, while the vocational aspect, if it refers to agriculture, should be directed to the practice of agriculture and the sciences connected with it. The classes should occupy one whole day a week. Where transport difficulties exist residential courses for consecutive periods of 7 or 8 weeks a year could be established. Practical training in the workshop and crafts, farm carpentry and the use and upkeep of the implements and farm machinery in addition to the theory of farming practice should be emphasized. Continuation classes should be carried out at the senior schools and Young Farmers' Clubs should be established for those attending the continuation classes.

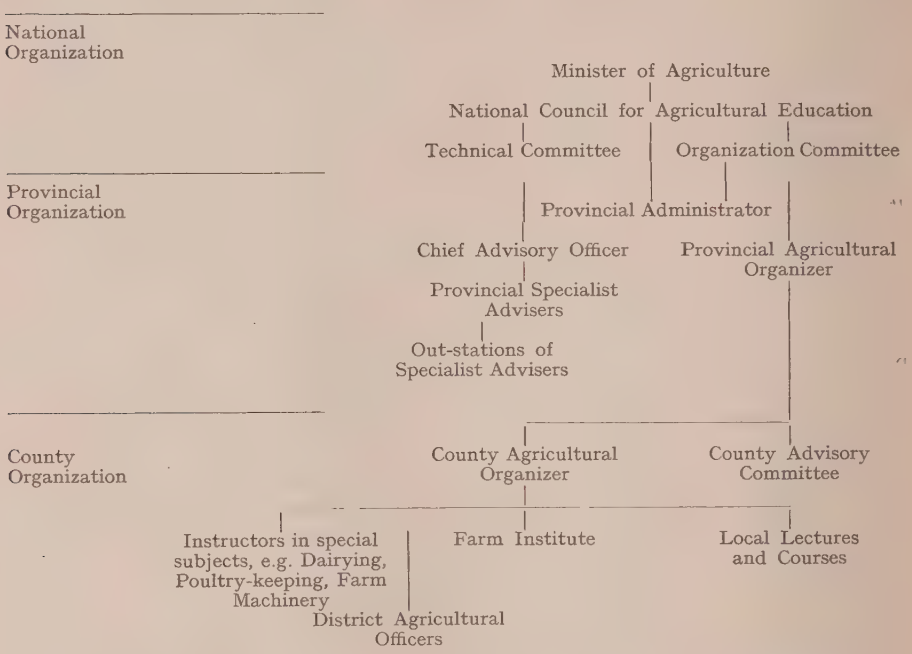
Finance and Control of Agricultural Education.

The Ministry had not attempted to exercise its powers of inspecting the teaching methods and activities in Agricultural Colleges and Farm Institutes. The policy of using inspectors trained under the Board of Education was discontinued. This is a serious defect which requires remedying.

The committee recommends setting up a central statutory authority to be called the National Council for Agricultural Education. It should be outside the Ministry of Agriculture but under the control of the Minister. It should include representatives of the industry, the Ministry of Agriculture, the Board of Education, the Agricultural Research Council and the Universities. The chairman should be appointed by the Minister from outside the Ministry. The chairman should have the assistance of two permanent vice-chairmen, one with scientific and agricultural qualifications and experience and the other, in addition to technical knowledge, wide administrative experience and capacity. It should be in close relation to the County Advisory Committees. Its work should be carried out through an Organization Committee, of which the provincial administrators should be members, and there should be a separate technical committee to advise on technical matters and to maintain contact with the Agricultural Research Council. The complete set up of the agricultural services as proposed by the committee is illustrated in the following diagram of the proposed organization.

It will be noticed in this set-up that special consideration is given to the Provincial and County Advisers. Frequent conferences between all sections are emphasized. The cost is estimated at £3½ million, which includes capital costs for Farm Institutes, etc. Salaries suggested for various officers are £2,500 per annum for the Chairman of the National Council and £2,000 for each of the Vice-chairmen ; £1,500 for the Chief Inspector of the Educational Inspectorate ; £1,500 for the Provincial Administrator and £680 for the scientific officers of his specialist staff ; £1,000 for the County Organizer and heads of the specialized Advisory Service ; and £500 for district officers.

Diagram of Proposed Organization.



IMPORTANT FEATURES IN RECOMMENDATIONS OF COMMITTEE.

(1) All post-primary schools to be of equal status.

(2) General science, including biology, rather than specialized sciences to be taught at all senior schools, both in rural and urban areas.

(3) Day continuation classes to be established for pupils over 15 who have left school.

(4) All senior schools should have a school garden and be equipped to teach general science.

(5) Young Farmers' Clubs to be encouraged in senior schools and in continuation classes.

(6) Agricultural education to be controlled by a National Council, with a personnel embracing representative interests.

(7) Improved standardization of courses at Farm Institutes, Agricultural Colleges and Universities.

(8) Extension, co-ordination and greater use of Advisory Services.

A minority report was submitted by one member of the Committee (Mrs. Youard), who considered that the local education authorities and Board of Education should control agricultural education. The Director and Secretaries for Education in a memorandum of evidence to the Committee also favour control by the Board of Education.

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The Australian Food Position*

By

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Japanese belligerency and the arrival of Allied troops in Australia inevitably meant new and greatly increased responsibilities for Australian agriculture. The demand for certain foodstuffs such as vegetables, pig-meats, egg and dairy products increased very considerably and it also became necessary to organize and equip an extensive food-processing industry as it was apparent that considerable quantities of food would be required far distant from the point of production.

The production of new and relatively new crops such as canning beans and blue peas had to be undertaken on a large scale and the growth of many other crops such as carrots, cabbage, silver beet and other vegetables had to be extended to areas where hitherto commercial production had been unknown.

The basic problem facing Australian agriculture after Pearl Harbour was to expand food production in spite of a serious depletion of rural man-power and acute shortages of agricultural machinery and other essential equipment as well as fertilizers, insecticides and various types of seeds, particularly of vegetables. The extent to which Australia's man-power has been mobilized for war is not generally appreciated. The latest official figures taken from "Facts and Figures of Australia at War", issued by the Department of Information in December, 1943, show that enlistments in the three fighting services total 858,860. This represents nearly two-thirds of the male population between the ages of 18 and 40 years and on a comparative population basis is equivalent to about 16,000,000 men in U.S.A. and over 5,000,000 in Great Britain. An additional 323,000 men and 191,000 women are engaged in direct war work, the latter figure including women enlisted in the services and in nursing and auxiliary units.

The depletion of rural man-power through enlistments and the transfer of rural labour to essential secondary industries has been the main factor restricting agricultural production. According to official figures recently released by the Acting Commonwealth Statistician the total number of male employees engaged in rural work has decreased from about 200,000 before the war to 120,000 in March, 1943. Over the same period, farm owners, lessees and unpaid relatives working on farms have decreased from 300,000 to 240,000 while women engaged in the rural industries have increased from 20,000 to 60,000.

The rural labour shortage became so acute that in September, 1943, Federal Cabinet acting on advice of the War Commitments Committee decided that 15,000 men should be withdrawn from the services for rural work, particularly in the dairy industry. The proposal was to extend these withdrawals over a period of ten months and although there was an initial lag in the rate of discharge from the services, a recent official announcement stated that so far more than 8,000 men had been released for return to rural work. A release of this magnitude will have little effect in overcoming agricultural production problems directly due to man-power shortages, as the total depletion of rural workers is in the vicinity of 140,000 men. The basic problem of increasing food production in spite of serious shortage of rural labour is likely to persist, and the extent of this problem may be gauged from a recent Press statement issued by the Minister for Commerce and Agriculture wherein it was stated that at present Australia is feeding the equivalent of a civilian population of 12,000,000 people.

* Presidential address to the New South Wales Branch of the Institute on 11th February, 1944.

Wheat and Rice Production.

The area sown to wheat in Australia has shown a progressive decrease since the outbreak of war and the decline has been very marked in the past two seasons. From an average area of 13 million acres devoted to wheat in the immediate pre-war years, the Australian acreage fell to $9\frac{1}{4}$ million acres in 1942–43 with a further decline to about $7\frac{3}{4}$ million acres in the 1943–44 season.

Despite the very large reduction in acreage, stocks have continued to accumulate due to the loss of the greater part of our export trade, a good season in 1941–42 and an abnormally high average yield per acre in 1942–43, when 157 million bushels were harvested from $9\frac{1}{4}$ million acres. At the end of June, 1943, wheat stocks in Australia amounted to about 200 million bushels compared with 140 million bushels at the corresponding period of 1942 and an average of 60 million bushels for the immediate pre-war years.

For the 10-year period prior to the war the average annual production of wheat in Australia was 178 million bushels. In 1940–41 it fell to 82 million bushels owing to an extremely adverse season. In 1941–42 it was 167 million bushels, in 1942–43, 152 million bushels, and in 1943–44 it was estimated at 95 million bushels.

The total usage of Australian wheat for the wheat year ending November 30th, 1943, amounted to about 93 million bushels, of which 35 million bushels were exported, compared with a normal pre-war export average of about 100 million bushels.

Recent orders placed by Great Britain for 250,000 tons of wheat and 500,000 tons of flour, together with the low production of 95 million bushels during the past season, have materially altered the outlook for the 1943–44 wheat year and it has been estimated that by the end of 1944, stocks will probably be reduced to 120–125 million bushels, excluding the 1944–45 crop.

The decline in wheat production has been largely a direct result of government policy in fostering the production of other crops at the expense of wheat, and although the overall supply position has justified this policy of restriction, definite steps must now be taken to prevent any further decline and to ensure that production is increased very considerably beyond the exceptionally low figure of the past season. This applies particularly to wheat production in the eastern States where the main depletion in stocks has occurred, and, although considerable surpluses may be held in South Australia and Western Australia, the question of transport difficulties makes it essential to increase production in the three eastern States.

The World Wheat Situation.

Wheat stocks in the four main exporting countries, Canada, U.S.A., Argentina and Australia, have risen very considerably since the outbreak of war and according to a recent statement issued by the Division of Marketing and Economics of the N.S.W. Department of Agriculture the carry-over for the 1942–43 season was 1,493 million bushels, which is approximately three times the normal carry-over in the immediate pre-war years. This large increase in stocks is mainly due to excellent war-time harvests in Canada and to a lesser extent in U.S.A. and to restriction of exports from Australia and Argentina.

During recent months there has been a very considerable increase in domestic consumption of wheat in U.S.A., Canada and the Argentine, and it is estimated that by the end of the 1943–44 year the world carry-over will have declined to 960 million bushels. If American usage continues at the rate operating in recent months, it is likely that U.S. stocks will be exhausted by the end of 1944–45. The U.S. Government is asking for a substantial increase in acreage for the 1944 crop and has set an objective of 68 million acres which is 14 million acres in excess of the area sown in 1943.

At present no increase in production is contemplated in either Canada or Argentina.

Rice.

From the outbreak of war until the 1941–42 season the acreage sown with rice in Australia remained very constant at 23–24 thousand acres, although annual production varied from 34,000 to 51,000 tons of paddy.

In 1942–43 the acreage increased to 34,000 and production reached 57,000 tons, which was 2,000 tons in excess of the production goal. The rice goal for 1943–44 has been set down at 40,000 acres of which 35,000 acres have been allocated for sowing on the Murrumbidgee Irrigation Area and 5,000 acres on a new area at Wakool. The latest information shows that actual sowings have amounted to 34,500 acres on the Murrumbidgee Irrigation Area and 4,100 acres at Wakool. Reports also show that present crop prospects are quite favourable and it is anticipated that the actual yield will be between 65,000 and 70,000 tons of paddy rice.

Rice has been practically unobtainable for civilian use for some considerable time and in view of the large Service demand and the requirements of various Pacific Islands, it is doubtful if the civilian supply position will show much improvement even though production has increased very considerably.

The Meat Industry.

The number of livestock in Australia has increased considerably since the outbreak of war. Sheep have increased by 13½ million and now number 124½ million. Cattle have increased by over 1 million and now number 14 million. The cattle increase has been almost entirely in beef types, as the number of dairy cattle has remained fairly constant at the pre-war figure of 5 million, although there has been a decrease in the numbers of milking cows. The pig population has increased by 407,000 and now amounts to 1½ million. Meat production has also increased considerably since the outbreak of war, rising from 963,000 tons in 1938–39 to 1,052,000 tons in 1942–43.

Production for the calendar year 1943 has been estimated at 999,000 tons, and in order to meet Service and export requirements for 1944 as well as providing unrestricted supplies for civilians, production would need to be increased to about 1,350,000 tons. The normal civilian requirement is about 700,000 tons, but rationing is expected to reduce this figure by approximately 150,000 tons. The meat production target for 1944 was originally set down at 1,180,000 tons, comprising 560,000 tons of beaf and veal, 477,000 tons of mutton and lamb and 143,000 tons of pig-meats. These objectives represent increases of 4, 15 and 44 per cent. respectively over the production achieved in 1943. Meat control authorities now consider the objective of 1,180,000 tons to be unobtainable and estimate that actual production in 1944 will approximate to one million tons.

It is unlikely that any reduction will be made in the civilian meat ration, at least for some time to come, and accordingly the deficit will need to be taken up by still further reducing exports and applying some restrictions on supplies to the Allied Forces.

The main shortages of meat are in beef and pig-meats, and as the Service requirements for these items are particularly high it is certain that the civilian meat ration will largely consist of mutton and lamb.

The requirements of meat for processing purposes have also increased very considerably during the war years and the anticipated output of canned meat for the year ended June 30th, 1943, was 68,000 tons, which was more than four times greater than the pre-war output. The objective for the calendar year 1943 was 100,000 tons.

Prior to 1939, meat dehydration had not passed the experimental stage, but the output for the year ended June 30th, 1943, was expected to be about 1,000 tons and the total objective for the calendar year 1943 was 3,000 tons with a production target thereafter of 5,000 tons a year.

The Dairy Industry.

To meet all requirements for dairy products in 1943–44, 1,300 million gallons of milk would need to be produced. This represents a 16 per cent. increase over actual production achieved in 1942–43 and as there was little chance of its attainment the milk production objective for the current year has been reduced to 1,210 million gallons which, however, is still 7 per cent. in excess of 1942–43 production. The present objective includes 175,000 tons of butter, 45,000 tons of cheese and 76,000 tons of other processed milk products. Actual production of these items in the previous year were 170,000, 35,500 and 64,000 tons respectively. The 1943–44 programme thus involves a 3 per cent. increase in butter and a 27 per cent. increase in cheese production as well as a 19 per cent. increase in the output of processed products including condensed and powdered milk and special milk foods, although the anticipated production of the latter item was to be reduced to 3,400 tons from the previous year's output of 4,700 tons.

As the season advances it becomes increasingly obvious that the dairy production target will not be attained. Statistics for the first quarter ending September 30th, 1943, show that butter production was 25 per cent. and cheese production was 15 per cent. below the output for the corresponding period of last year. A recent analysis of the position by the Controller of Dairy Products, based on actual production for the six months ended December 31st, 1943, and an estimate of production for the ensuing six months indicated that total production expressed as milk is unlikely to exceed 1,135 million gallons, which is 75 million gallons below the objective. According to this analysis actual production is expected to be as follows : butter, 160,000 tons ; cheese, 37,000 tons ; processed milk products, 68,000 tons.

The decline in butter production is particularly serious in view of our export commitments to Great Britain, and it appears likely that some reduction in the Australian civilian ration of 8 oz. per week will be necessary, if any attempt is to be made to supply Great Britain with her minimum requirements to maintain the British ration of 2 oz. per week.

The number of dairy cattle in Australia has not altered appreciably since the outbreak of war and remains at about 5,000,000 of which 3,208,000 are dairy cows. One serious feature of the dairy industry has been a recent decline of about 230,000 in the number of cows being milked. The industry has also been seriously affected by man-power depletion and, under existing circumstances, there is little prospect of arresting the decline in production.

The Vegetable Industry.

Despite serious production difficulties involving shortages of manpower, seeds, fertilizers, insecticides, fungicides and all types of mechanical equipment, there has been a remarkable increase in Australian vegetable production since the outbreak of war. The total area sown to vegetable crops including potatoes increased from

TABLE I.

Vegetable Production in 1942–1943 and Requirements for 1943–1944.

Vegetable.	1942–43 Production. Tons.	1943–44 Objective. Tons.	Increase. Per cent.
Potatoes	475,000	529,000	11
Tomatoes	72,000	163,000	126
Green peas	26,000	72,000	177
Blue peas	12,000	16,000	33
Navy beans	3,000	5,000	67
Other vegetables	475,000	502,000	6
Total	1,063,000	1,287,000	—

218,000 acres in 1938–39 to 331,000 acres in 1942–43, while the production targets for 1943–44 will require a total area of 468,000 acres for their fulfilment. A summary of the vegetable requirements for 1943–44 compared with actual production in 1942–43 is given in Table 1.

The principal increases in areas required to be sown with vegetables for the fulfilment of the 1943–44 objectives are given in Table 2.

TABLE 2.

Areas sown with certain vegetables in 1942–43 compared with areas required to be sown for fulfilment of 1943–44 production objectives.

Vegetable.	Area sown in 1942–43. Acres.	Area required to be sown in 1943–44. Acres.
Potatoes	140,000	174,000
Green peas	33,000	80,000
Blue peas	33,000	42,000
Pumpkins	27,000	30,000
Tomatoes	17,000	25,000
Cabbage	9,000	14,000
Carrots	6,000	15,000
Navy beans..	6,000	15,000

It is certain that the total vegetable production targets will not be achieved and it is estimated that sowings will fall 60 to 70 thousand acres below requirements, while dry weather during the past three to four months will reduce yields considerably in many parts of the eastern States.

The increase in vegetable production has been due almost entirely to the necessity of fulfilling Service requirements for fresh, canned and dehydrated vegetables. Despite greatly increased production, vegetables have mostly been in short supply on the civilian market, although there have been temporary gluts of perishable vegetables from time to time.

The problem of feeding large numbers of troops in areas far distant from sites of vegetable production has made it necessary to process considerable quantities of various vegetables and the requirements for canning and dehydration are constantly increasing. The output of canned vegetables in 1942 amounted to 22,000 tons and the anticipated output for 1943 was 50,000 tons. Dehydration of vegetables was an entirely new industry for Australia and anticipated output for 1942–43 was 1,000 tons. The objective for 1943–44 however was 10,000 tons, involving the treatment of about 80,000 tons of fresh vegetables. Arrangements are now being made for the processing of vegetables in Australia by the rapid freezing technique which has proved so very popular in U.S.A., but the output in the immediate future is not expected to be large.

The Commonwealth Food Control Directorate in collaboration with State Departments of Agriculture has attempted to produce all Service requirements of vegetables by arranging definite contracts with growers. Despite certain defects the scheme has been generally successful and a proposal is now being considered whereby the contract system of production will be extended to cover about half the total quantity of vegetables required for civilian consumption. This scheme is designed to provide growers with an assured market price for at least portion of their crops, and thus remove some of the market hazards which are likely to have a restrictive influence on production.

An official survey of Australian vegetable growers in the latter part of 1943 showed that, according to the returns forwarded by growers, the main factors hampering vegetable production were shortages of the following types, in order of

frequency : fencing wire ; labour ; fertilizers, insecticides, fungicides and spraying equipment ; essential machinery ; essential spare parts.

It is certain, however, that the order of importance of these factors differs considerably from their order of frequency, as shortage of fencing wire, for example, has been a much less important factor in restricting production than has shortage of labour or shortage of machinery and essential replacement parts.

The Fruit Industry.

Service requirements have increased the demand for fruit very considerably but as fruit production cannot be expanded at short notice, Service requirements have been met at the expense of civilian supplies.

Citrus fruits have been in great demand for juice manufacture and citrus control orders were gazetted during 1943. The first provided that citrus fruit could not be sold except as directed by the Commonwealth Food Control Directorate. Prices were fixed for various classes of citrus fruit. Later orders provided that 25 per cent. of the total orange crop, 50 per cent. of the lemon crop and 100 per cent. of the grapefruit, Seville and Poorman orange crops should be supplied for Defence purposes. A control order was also gazetted controlling the disposal of peaches suitable for canning purposes. The requirements for canned fruit have increased considerably and the production objective of $3\frac{1}{2}$ million cases for 1943–44 represents a 75 per cent. increase over the 2 million cases produced in 1942–43. The objective for dried vine fruits has been increased by 6 per cent. from 90,000 to 95,000 tons.

Egg Production.

The egg production goal for 1943–44 is 100 million dozen, compared with an estimated production of 90 million dozen last year and 88 million dozen in 1941–42.

There is a huge demand for eggs for pulping and powdering for Service use and it is certain that civilian supplies are going to be very short, particularly until the new season's production commences next spring. Moreover, distribution of eggs is controlled by the Commonwealth Food Control and accordingly supplies can be diverted readily from the civilian market to meet Service requirements. Egg production has been affected seriously through shortage of incubators and other essential materials and equipment and there has been considerable dissatisfaction in the industry with prices and with the general administration of the egg control scheme.

General Considerations.

Despite all the difficulties of war-time production, Australian farmers have done a magnificent job and the output of essential foodstuffs has been expanded very considerably to meet the new demands.

Many of the production difficulties have been unavoidable under war-time conditions, but some of them at least could have been avoided had there been more definite direction of our agricultural policy. For example, the manner in which the market for pig-meats was allowed to collapse several years ago following Britain's inability to provide the necessary shipping for transportation had a very serious effect on the subsequent expansion of the industry. Likewise the recent failure of the Food Control authorities to prevent the collapse of the market for certain types of green vegetables during temporary glut periods has also induced an undesirable feeling of insecurity amongst growers, particularly as the need for increased production of all types of vegetables has been publicized widely by both State and Commonwealth authorities.

Competent overall direction of Australian agriculture has been an urgent necessity since the outbreak of the Pacific war, but unfortunately existing Commonwealth Departments have been at a serious disadvantage in accepting responsibility

for war-time food production. Under pre-war conditions these Departments had little experience in the formulation and direction of agricultural production policies, and accordingly it had never been necessary to build up a staff of competent agricultural advisers and administrators. With the assumption of definite responsibilities for food production the Commonwealth authorities were faced immediately with serious difficulties in obtaining suitable staffs, and unfortunately State Departments were often unwilling to release suitably trained personnel for service in the Commonwealth sphere.

Official action taken to assist certain types of food production appears to have been based on political expediency rather than attempting to effect some permanent worth-while improvement in the industry. This applies particularly to the dairy industry where a direct subsidy payment of £6,500,000 a year is being made to producers in order to avoid an increase in the selling price of butter and other dairy products. A direct subsidy of this nature will not increase production nor will it assist in the betterment of the industry. It is certain that the dairy farmer was entitled to a greater price for his product in view of increased war-time production costs, but this increase in cost should have been passed on directly to the consumer and any subsidy should have been payable only for the adoption of better farming methods. The principle of subsidy payments for good farming practices has been very successful in U.S.A. and it is certain that if Australian dairymen were paid a subsidy for fodder conservation and pasture improvement and given financial assistance for the purchase and breeding of better livestock a very worth-while improvement could be effected in dairy production even under existing conditions.

Another factor having a restrictive influence on the production of certain foodstuffs has been the maximum prices fixed by the Commonwealth Prices Commissioner, and although official action to prevent an inflationary trend is desirable, it is certain that essential agricultural production will not be obtained unless the prices received by the grower are sufficiently high to enable profitable production to be undertaken.

Acknowledgment.

In the preparation of this paper the writer has drawn freely on information published in (1) " Facts and Figures of Australia at War ", issued by the Commonwealth Department of Information ; (2) " The Food Front " (News Bulletin of the War Agricultural Committees of Australia), issued by the Commonwealth Food Control ; and accordingly it is desired to acknowledge indebtedness to these two publications for the information obtained therefrom.

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Surveys for Potential Land Use

By

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Potential land use is a subject of considerable importance in other countries but so far in Australia has not passed the stage of being solemnly discussed. One reason may be a tacit objection to sinking individual contributions in the common pool of knowledge of a team of workers. We are inclined to be individualists and isolationists both personally and as institutions, paddling our own canoes, sometimes suspicious of possible credit grabbing. In this work on potentiality nobody is completely self-sufficient, and many workers may, and should, contribute. It is the aggregate and balanced sum of the facts produced which determines the best use of the land. The survey for potential land use is not a statistical or arm-chair study or a matter of opinion without research. It aims at a scientific evaluation of the land by collecting basic data along different lines and integrating it with the aid of sound commonsense. It is not a one-man job but demands a team of some varying number of specialists. This involves for example any or all of such specialists in soil survey, agronomy, engineering, forestry, soil conservation, animal husbandry and diseases, climatology, irrigation and geography. In the majority of cases the first three are always wanted, but conceivably all may be required to go into the field and at the end to sit round a table and discuss the potentiality of the soil and land types with a view to planned development. The table in any case should be round.

Soil Surveys.

The beginning of all such studies, the foundation on which all other considerations rest, is the soil survey. It is not necessary today in most circles to make out a case for soil surveys and allied soil investigations. Their significance is recognized by governments, land holders and private bodies concerned with development of new areas and they are rightly regarded as the first sound step in settlement projects. We meet, of course, in our travels the practical man who reads the country " like a page of music " but he is exceptional and unfortunately usually dies without leaving such a well-informed successor, particularly as clearing and firing have in the meantime removed many of the useful notes from the page. All must return to the study of the soil itself, the agronomist for interpreting and applying the results of his experimental plots, the conservationist in dealing with eroding and resisting soils, the irrigationist concerned with variability in absorption and drainage of water, the ecologist for his study of plant associations, and so on.

The basic soil survey studies the soils of a selected area of any magnitude, classifies the soils according to their characteristics into types and maps the extent of each. The soils are classified into types for the benefit of the farmer, the adviser, and the agricultural investigator. The survey is tied to land use and the detail is decided according to requirements of the case. An attempt is made to show minor differences sometimes, such as phases of soil types—deep, shallow, gravelly, steep, etc.—with the idea of making the classification and map more useful. Different types are never run together on agronomic grounds, but may be separated on slender differences if backed by ecological or agronomic evidence. The effort put into the work and detail is balanced against the comparative economic value of the results.

A technique is being developed of mapping large areas according to groups of soils rather than individual types. This provides a skeleton picture of the soil distribution on which detail can be filled in according to the suitability for, and possibility of, more intensive use. With the broad-scale survey which can be done

at some speed (with aerial photographs, say 100 square miles or more per month per surveyor) a number of detailed spot surveys are carried out covering typical units of country, e.g. 500 to 5,000 acres in extent, depending on conditions. These provide a pattern of the occurrence of soil types and enable the soil-group map to be more readily interpreted by other workers. For rapid and comparatively cheap work to serve as a sound basis for future more intensive investigation and to define the problems of effective land use, these surveys are proving worthwhile. They require, however, a well skilled soil surveyor.

The soil classification should not change and a soil map should not need to be remade if the survey is properly done, unless more detail is required in the future, e.g. in setting up a new irrigation area man-made changes such as those due to accelerated soil erosion or waterlogging are superposed on the original map. It is therefore the basis, on which other investigations and the whole plan of proper land use, is built.

There are several things which the soil surveyor does automatically during field work besides making observations on the soils. One is to describe and map the land-use pattern. This involves the ecology of virgin areas as far as knowledge will permit though there are limits to the skill of the ordinary soil surveyor in this regard. A great deal of information is collected with the aid of botanical specimens for identification while noting also their habitat and associations, so that a working acquaintance with native flora is built up fairly quickly. The crop position is covered on each farm and as far as practicable, depending on the details being collected, the crop quality also as associated with soil type, topography, drainage, aspect and management. A large number of farmers is spoken to as a regular feature of the work and some of them at length after the survey is complete. The soil surveyor is in this way very well acquainted with the agricultural position—in fact it is commonly true that he knows more about the area than any other officer or local inhabitant of the oldest vintage.

A second feature is the definition of problems facing agricultural advances in the district. Months of continuous traversing the country, examining soils, talking to farmers, brings out any production problems and these as defined are the basis for further investigational work by appropriate workers.

Thirdly, there is the noting of special soil features which go along with the mapping of soil types such as degree of erosion, soil salinity, and waterlogging. These features are sometimes recorded in detail with working plans, although the plans are not usually published. The reason is simply that they may be changed suddenly and materially and the plan lose its usefulness except for comparative reasons. The erosion pattern may be altered seriously in one violent storm at a critical time of the year, salinity and waterlogging improved through drainage, while the whole system of land use may be radically altered through effect of outside forces such as markets in foreign countries. The information is collected and mapped for the use of advisers, farmers and for investigational purposes.

Summing up, the prime duties of a soil surveyor are : (1) soil classification and mapping, (2) mapping of present land use and ecological observations, (3) mapping and study of special features as erosion, salinity, waterlogging, and (4) definition of agricultural problems for investigation by specialist officers.

In emphasizing the work of the soil surveyor we should not in any way overlook the part played by the laboratory analyst and research worker in the physics and chemistry of soils. There should be full cooperation and understanding between field and laboratory. Much more should be asked of the chemist and physicist. One cannot, for example, deal adequately with the field assessment of irrigability or erodibility of soils without the aid of the soil physicist and we should insist on the survey being followed by properly designed and controlled experiment in the laboratory and field. We are a long way from using the effective collaboration of laboratory and field research in pedology. Standard testing of soils is often slow,

inadequate, and uninspired. We need a line of good research chemists and physicists to work along with the field research in soils and, so far, as a body they are rather conspicuously absent. One of the difficulties is the lack of methods and this is a plea to the soil chemist and physicist for helpful research and assistance in this regard.

Investigations following the Soil Survey.

In considering what can be done with the land the soil survey should be followed by investigations along certain lines involving other agricultural agencies. Making plans for, and soundly advising on, the proper use of land, is a cooperative job. There are five main lines of attack after the survey is completed, but some at least should be begun concurrently with the later stages of the work. These lines (not in order of importance) are (1) climatological study, (2) investigation of agricultural problems of the area, (3) mapping of land use, (4) studies in agricultural economics, (5) determination of potential land use, including management and plans for improvement.

(1) *Climatological Study.*

Analysis of climate is necessary for the investigation of land use discussed in the following sections (2), (3) and (4). This factor is dealt with in some detail as despite its obviousness some points are overlooked by many workers.

As is well known, total rainfall is not so informative as seasonal fall. Some workers prefer the fall over the growing period, in round terms over six months, others work on the wettest and driest four months as being significant, others on a precipitation-evaporation ratio. But in particular we want to know the reliability of fall both in total amount and at critical periods. Examination of daily records over long periods for frequency and magnitude of falls makes very laborious work, but it is important evidence. In southern Australia the study narrows to probability of effective falls in certain portions of the year. In areas with doubtful length of season, the reliability of breaking rains say in April or May or in September or October is very important. What constitutes an " effective " breaking rain is not calculable by rule-of-thumb. It depends on the amount, the concentration of fall, the subsequent weather conditions and the soil type. When daily records are examined a balanced judgment may be made for each case. The significance lies in the greater comparative value of two or three weeks' good growing weather early compared with late in the season.

Frequency of summer storms becomes important in fruit-growing areas, owing to, for example, hail damage, or splitting of fruit. In country which erodes, heavy storms in summer, or at about seeding time in parts of the wheat belt, may carve a fearsome pattern on the sloping land. Washing, deposition, inundation can be considered in terms of climatic analysis, topography and soil types.

With some crops other climatic features need consideration, such as relative humidity, length of frost-free period, wind direction and velocity. Again, topography, aspect and natural cover come into this question. In all cases climatic data needs some examination ; in the difficult cases it demands skilful attention and much more than arm-chair analysis.

There is another angle which concerns microclimate and is intimately associated with soil, topography and vegetation. A little thought would make clear that on a slope with soils of low permeability under a rainfall of, say, 25 inches the soil for plant growth may be in a condition all the way from semi-arid at the top of the slope to sub-humid at the foot. Or consider the case of crab-holey soils where growth is satisfactory on the mounds in wet seasons, in the depressions in dry seasons, and not often optimum for both. Or again the case of downhill seepage, which under well covered slopes may go on long after rains have ceased, so that the length of

season for shallow-rooting plants may be progressively greater descending the slope while in the bottoms, in higher rainfall areas, summer grasses and crops may be grown effectively in the otherwise dry months. All field men are aware of the relationship of soil types and their internal and external drainage conditions with vegetation associations or growth of crop. We should never forget the nature of the soils and topography in evaluating climatic data but read the rainfall analysis with a soil map as a guide.

(2) *Agricultural Problems.*

In the course of the field work of the soil survey a comprehensive grasp of the agricultural situation is obtained and the problems confronting development become defined whether they concern plant, animal or soil. Simple ecological observations point to plant-nutrition troubles and, not infrequently, analogous symptoms and circumstances previously observed may lead to useful suggestions to the investigator coming fresh to the area. The necessity for careful selection of experimental sites by the soil surveyor is insisted on ; there have been far too many unwise selections of such sites by workers not appreciative of the soil factor in field experiment. Problems such as infertility of soils due to lack of essential elements for plant nutrition, or concerning diseases of stock, either a deficiency or excessive supply of minerals, e.g. cobalt or selenium, gathered in the general round of surveying can be investigated by specialist workers. This data is needed before any detailed potentiality study can be arranged.

There are other cases to be examined besides the nutritional aspect. For example, natural swamps may require drainage, dry soils may be irrigated, eroding soils may be conserved. These points call for the engineer who should come in, as the problem is defined, with his skill in design. Engineers are very good fellows with an incurable desire to construct ; it is a good thing often to examine the physical and agronomic considerations at the same time.

In all this work the investigations should go forward *pari passu* with the later stages of the soil survey and the workers be co-opted as soon as the problems begin to take concrete shape. The job should be tackled soundly and scientifically as man-power is available, *not* as a part-time occupation of an advisory service.

(3) *Land Use and Present Production.*

The present use of the land should be recorded on a map which may be superimposed on the soil map to show the relation of improvement to soil types. In old-established districts the existing usage is the result of trial and error over long periods and is relatively stable ; in new districts things are usually in a state of flux. This does not infer that old as well as new districts may not change, but the task of assessment of productive capacity for them on present knowledge is easier. The soil surveyor with specialist advice can efficiently collect and map this data and it may add an additional 10 or 15 per cent. to his working time. We would like to define a soil surveyor as a broad-minded agriculturist with a specialist knowledge of soils, but there are many finer points in determining productive capacity which are beyond him as a rule. For example, amount and quality of millable timber in a forest, specific methods and costs of clearing, finer details of pasture quality and agronomy of unusual crops, engineering matters such as drainage, may all be questions entering the field of present land use. It is desirable therefore that specialists *come into the field* with the surveyor, and if not actually dealing with the survey, supply reliable yardsticks for the work.

There is a further point calling for teamwork, and that is estimation of productivity rating. It has not been tried in Australia, but has been widely experimented with in U.S.A. Various methods have been devised which need not be detailed here. One is to assess a maximum production level for the individual crops grown

in the district and rate the soil types on a scale of ten points according to their capacity to grow this crop. For example, maximum wheat yield might be fixed at 30 bushels and a soil with this production would be assessed as ten, one producing fifteen bushels at five. The maximum levels and the production per soil type are fixed by a round table discussion between agronomists, foresters, other specialists concerned and the soil scientist. To quote an example from an Oregon, U.S.A., survey, the Powell silt loam is rated as follows : wheat, 7 ; oats, 8 ; potatoes, 7 ; clover, 7 ; alfalfa, 5 ; vetch, 8 ; apples, 8 ; prunes, 8 ; walnuts, 9 ; strawberries, 9 ; pasture, 8 ; and forest, 10. The soils may also be given a rating as to general agricultural value and the Powell silt loam is placed in the highest group on this score.

The productivity rating is better than a guess when dealt with in this way. It becomes the concensus of well informed opinion with many factors taken into account. It cannot have mathematical precision but may be of very great value to advisers, valuers and those planning better use of the land.

(4) *Agricultural Economics.*

The study of agricultural economics has been the most neglected field in Australian agricultural investigation, but it should take an important place. The comparative usefulness of an agriculturist with little economics or an economist with little agriculture is still being debated. One can learn the principles of economics easily enough in a classroom, but not the practice of agriculture. We must train a line of agricultural economists skilled in both branches and not expect them to blossom too young. The investigator must go into the field for a long period, must collect his data personally, if painfully, rather than by circulating academic questionnaires, and the working up of the information must be done against the background of personal knowledge of the country concerned. The economic aspect is of prime importance in planning, but it must be studied on the spot, as much as the soil or pastures, and it must go along hand in hand with the studies of soils and land use. The economics of regenerating hardwood forests in opposition to grazing milking cows or planting an apple orchard cannot be seen in quite the right perspective with the office telescope some hundreds of miles away in the city, nor can the assessment of erodibility of the landscape under these usages be properly appreciated. The agricultural economist must collaborate closely with his fellow team of agricultural scientists.

Study of rural sociology is here tacked on to the economic discussion. They are related closely and in discussing land-use plans both are significant. The more one works in the country, the greater becomes the appreciation of this factor. One would like to see the good work begun in this field expanded widely.

(5) *Potential Best Land Use.*

Following logically from the preceding work is the determination of the proper use of the land based, of course, on our present knowledge. It has been proved many times that describing soils as " useless and poor " for development applies to the temporary state and such a statement should be qualified by the phrase " on present knowledge ". Beginning from the productivity rating with accumulated evidence from sources described above in (1), (2), (3) and (4) and the soil survey, an attempt may be made to envisage an improved plan of land use. This may turn on such matters as the installation of a large drainage scheme, or an irrigation scheme, or a strong swing from a cultivation to pasture programme, or *vice versa* with the introduction of new crops. It is clear that continued prosperity of agricultural communities is often governed by even drastic changes in land use such, for example, as in areas subject to erosion or the more general condition of a degenerated state of soil fertility. Once the data from soils and present use is available, when the problems arising from them are on the way to solution, and the economic position is defined, there is no reason why a qualified team of investigators embracing all

necessary aspects should not work out the potential best use under any given set of conditions. With this opinion, any one, from the individual small landholder to the government, can follow a sound agricultural line.

Conclusion.

The job of the agricultural scientist is to carry the investigation of soils and land use to the stage of determining what *can* be done, but he should be wary of getting too deep in the realm of what *should* be done. That is not always measurable with any precision—it may be neither mathematical nor even scientific. Intangible determining factors may outweigh our considered verdict and the assessment of the political, international, strategic and social influences governing the economics and feasibility of production is outside the scientist's sphere. It is more probable he would lose his value in research and investigation proportionately to his entrance to this realm.

Many times in these pages the idea is insisted on that only by continued study of the field position in soils, agronomy, livestock, economics or other aspects can the sound evaluation of an area be made. We must go and stay on the job as long as there is need. Here we could begin a discussion on the regionalization of agricultural research, but perhaps the soundness of this is realized even if not practised by existing authorities. Finally, there must be a team, small or large, for adequate research and planning and for summing up the survey for potential land use. There must be above all complete understanding and harmony between the workers. The job is the thing.

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Summer-Rainfall Pastures and the Cattle Industries

By

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If the war has done one thing for Australia it has been to develop in the Australian people a realization of the importance of a strong North for Australia's military defence. What is equally true, but perhaps not yet so fully appreciated, is that a well developed North is of equal value to Australia's peacetime economic safety. Australia cannot expect to be a totally self-supporting nation, even if this were internationally desirable, and therefore she must look to means of maintaining and increasing her export trade. For some time to come this will depend largely upon the products of primary industry, and chiefly those based on pasture and forage crops, that is, the animal industries. In the pre-war year 1938-39, about 55 per cent. of Australia's total exports came from the meat, wool, and dairying industries.

Wool has been the greatest contributor to our export trade in the past, but it is now faced with competition from substitute fibres. One cannot predict what effect this competition will have on the post-war demand, but it seems unlikely that any increase in demand for wool can be expected in the near future, and that, in self-defence, the policy for wool must be one of reducing costs of production, rather than attempting to increase our total production. Similarly, the dairying industry

may have to face competition from vegetable oils, although this may not be so serious to our export trade for some years, until the world's dairy herds have been re-established. There may, therefore, be an opportunity to increase our exports from this industry after the war, but the rising costs of production experienced in the last few years indicate that here, too, means must be found for reducing them if production is to be maintained or increased.

At the moment, there is no important substitute competitor for meat, and with the increase in nutritional standards and the possibility of new markets, meat may offer possibilities for an increase in export trade. This opportunity, however, will only be of value if the quality of our export product, and the continuity of its supply, can be successfully improved.

Apart from the use of the correct type of animal and the control of animal diseases and pests, the nutrition of the animal, both with respect to the general level and uniformity throughout the year, is the most important factor determining quality and returns from given units of land and labour. The application of methods of pasture improvement, and improved methods of utilizing pastures, have played an important rôle in stabilizing and developing the stock industries in the South, but in the North this problem has scarcely been touched.

Cattle in the Summer-Rainfall Zone.

Australia's pastures fall into two major groups, namely, those of the winter-rainfall zone and those of the summer-rainfall zone. The line of equal summer and winter rainfall runs approximately from Carnarvon in Western Australia, in a straight line to Cobar in central New South Wales, and then south-easterly to Sydney. The two zones grade into one another and overlap, and atypical areas may be found in each, but by far the greater portion of Australia lies in the summer-rainfall zone, the ratio for the whole of Australia being approximately 2½ to 1.

With the exception of southern Victoria, the major concentration of cattle in Australia occurs in the summer-rainfall zone of Queensland and northern New South Wales; thus, Queensland alone has 30 per cent. of Australia's dairy cattle and nearly 50 per cent. of all cattle. As the major concentration of population, and therefore the greater home consumption, occurs in the southern part of Australia, the contribution made by the summer-rainfall zone to our export trade is greater than mere stock numbers would indicate. This is shown by the figures in Table 1, which indicate Queensland's production and overseas export of beef and butter in the pre-war year 1938-39 relative to that of Australia as a whole. As the northern half of New South Wales also lies in the summer-rainfall zone, it will be seen that Australia's exports of beef and butter are derived mainly from summer-rainfall pastures and fodder crops.

TABLE 1.

Production and overseas export of beef and butter, 1938-39. (Compiled from the Commonwealth of Australia Official Year Book No. 33, and Queensland Year Book No. 4, 1940.)

	Australian Production. (1,000 lb.)	Queensland Production. (1,000 lb.)	Queensland Production. Percentage of Australian Production.	Australian Exports. (1,000 lb.)	Queensland Overseas Exports. (1,000 lb.)	Queensland Overseas Exports. Percentage of Australian Exports.
Beef ..	1,252,631	304,957	24·4	271,949	221,851	81·6
Butter ..	455,834	157,626	34·6	229,543	127,546	55·6

The contribution made by the summer-rainfall pastures to the animal industries in other parts of the Commonwealth must also be considered. Thus, in the year 1939-40, movements of livestock and wool across the Queensland border into New South Wales resulted in a net export valued at £2,213,504 (Queensland Year Book No. 5).

Pastures in the Summer-Rainfall Zone.

Pasture improvement has been the subject of a considerable amount of research in Australia, but most of this has been concentrated in the south. In consequence, while there are available species and methods of pasture improvement applicable to a large proportion of the winter-rainfall pasture areas, very little is known regarding vast areas of summer-rainfall pastures. Davies[1] has estimated from mean annual rainfalls the gross areas (inclusive of otherwise occupied or non-utilizable areas) in which pasture improvement may be considered feasible, for the various States. His estimates are given in Table 2, together with the areas of artificially sown grasses, and the percentages of the gross areas sown.

TABLE 2.

The areas of artificially sown grasses in relation to the estimated gross areas suitable for pasture improvement in Australian States.

	Gross area. (Sq. miles.)	Area under permanent artificially sown grasses, 1939. Sq. miles.*	Percentage of gross area.
New South Wales and A.C.T. ..	183,169	5,006	2·73
Victoria	68,614	4,819	7·02
Queensland	253,000	2,381	0·94
South Australia	32,950	723	2·19
Western Australia (excluding the northern portion)	50,000	1,419	2·84
Tasmania	23,438	1,190	5·08

* Extracted from Commonwealth of Australia Prod. Bul. No. 33.

The table indicates not only the large areas potentially suitable for pasture improvement in Queensland and New South Wales, but also the small proportion of land in Queensland on which pasture improvement has been attempted. Regarding the latter point, the position is actually worse than the figures indicate. In the south there are balanced and stable pasture mixtures available for a wide range of soil and rainfall conditions. Thus, the major sown grasses and legumes, perennial rye, cocksfoot, Phalaris, Wimmera rye, with white, subterranean, red and strawberry clovers and lucerne, collectively cover a sufficient range of adaptation to provide mixtures suitable for conditions varying from the high-producing, better-rainfall areas to areas with poor soils and a restricted growing season. Further, the availability of a legume for almost all conditions where pastures are sown permits not only the maintenance of soil fertility, but also its improvement. Thus, in many areas of poor soil where subterranean clover can be established the subsequent raising of soil fertility often allows more productive grasses to be later introduced. In Queensland such a wide range of species is not available and moreover, sown pastures are, with few minor exceptions, almost entirely gramineous. For example, Rhodes grass, para grass and molasses grass are usually sown without an accompanying legume, and for this reason, their use is confined to first-class soils. They fail to persist in conditions of low soil fertility and even on the best soils their productivity steadily declines.

At the moment, there is no method, comparable to the use of subterranean clover in the south, whereby the productivity of second- and third-class soils in the

good rainfall areas of northern Australia can be improved and even on better soils existing pastures cannot be regarded as a final solution to the problem.

The position attained by the north, in exports of beef and butter, has been achieved in spite of relatively small support from scientific investigations into methods of pasture improvement. In this respect, the south has had initial advantages, not only in a greater concentration of population and finance, and a longer development, but also in the fact that by reason of its climate, it has been able to utilize many of the species, and methods, previously well tried and exploited in other parts of the world. Northern Australia is not very similar to any other part of the world. Only a small area can be considered typically tropical. Most of the remainder must be considered azonal so far as either the south or the tropics are concerned, and it constitutes a large intermediate area in which neither typically southern, nor typically tropical species, or methods, are successful. Its problems therefore are quite new and different, and pasture research for this zone has not been able to draw upon experience elsewhere. An examination of the problem, however, indicates that given adequate research, comparable to what has been possible in the south, the contribution to the stock industries by the application of pasture improvement and methods could be equally, or even more, important.

The Pasture Problem.

As reported by Hammond,[3] the present lack of quality in beef cattle is mainly due to the slow and interrupted growth of the young beast resulting from the irregularity of food supply. "As a consequence, the bulk of the beef is too old, too poor in conformation, and not well finished enough to be of first quality. For export purposes, it provides a supply of cheap frozen beef, but it cannot compete in any way with the better quality and uniform supply of Argentine beef." Davies[2] has defined the problem more specifically from the pasture point of view as being due to an irregularity of protein supply, rather than to actual bulk of feed.

The co-incidence of moist conditions and high temperatures in the summer-rainfall zone results in a tremendous flush of growth, which is of good quality in the young stages but deteriorates rapidly as the plants mature, when the protein value drops as low as 1·5 to 2·5 per cent. Often there is a considerable bulk of feed available during the dry winter and spring months, but its protein value is such that the animal loses weight and condition. In consequence, the maturation of the animal is delayed at least one year and the quality suffers.

This seasonal nature of the food supply is reflected in the marketing of stock, as owners tend to sell in winter when the feed supply becomes short. This results in a seasonal fluctuation in the number of stock marketed for export which is clearly shown in Figure 1, in which the monthly returns of numbers of cattle submitted for inspection for export in Queensland, New South Wales, and Victoria are compared.

There are several methods whereby the nutrition of the animal may be maintained at a more even level throughout the year. These are

(1) fodder conservation and supplementary feeding,

(2) growth of winter green-forage crops,

(3) improvement in pastures and pasture management.

In many of the breeding areas cultivation as a regular practice is not feasible, and distance from the fodder-producing areas raises the cost of supplementary feeding above the economic level. It is in these areas that the beef animal receives its first setback and pasture improvement must be the major solution to the problem. In areas of higher rainfall, where great yields are obtainable from cultivated fodder crops, their use will always have a place, but in these areas also, there is a need for

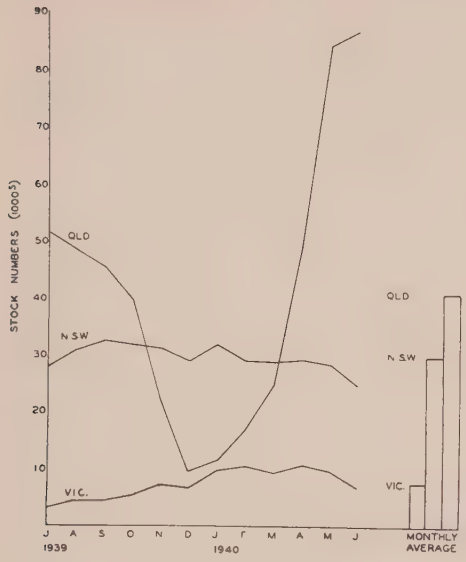

Figure 1.

Numbers of cattle (excluding calves) submitted for slaughter and inspection for export in New South Wales, Victoria and Queensland, during 1939-40 (extracted from Commonwealth of Australia Prod. Bul. No. 3).

the development of good pastures. The deterioration of soil structure and soil fertility in many of the areas where continuous cultivation has been practised will no doubt require that cropping will need to be rotated with pastures if a permanent agriculture is to be established. Then, too, there are lands in high rainfall areas, in which the slope determines that cultivation should not be practised. Here pastures, or reafforestation, offer the only means of production.

Many summer-rainfall pastures at the present time are of such low nutritive value by the time they reach the hay stage that their use for conservation is not warranted. An improved perennial pasture will offer a cheap source of fodder worth conserving. The growth of annual crops requires an annual expenditure of time and labour, and, from the economic point of view, it is clearly advisable that so far as is possible the problem should be solved by the use of perennial pastures and that annual crops should be used to fill remaining deficiencies. This applies, not only to beef fattening, but also to the dairying industry with its rising costs of production.

Legumes.

The quantitatively low proportion, often amounting to a complete absence, of legumes in northern pastures is one of the obvious and major causes of protein deficiency. In the south, white clover in moist areas, and subterranean clover on dry lands, successfully obviate this deficiency. These clovers are of value in only very small areas of the summer rainfall zone. Numerous native legumes occur, but these are mostly small trailing plants which, although of some value during the initial growth of native pastures, rarely occur in quantities of any consequence in mature pastures or amongst artificially sown grasses. An annual, *Stylosanthes sundaica*, accidentally introduced into northern Queensland, has proved of value in certain areas, and McTaggart[4] has described several introduced perennial species of the same genus as having potential value for northern pastures; Schofield[5] records promising results in coastal northern Queensland with various tropical legumes; lucerne has possibilities under certain conditions as a pasture legume in the southern part of Queensland and in New South Wales. However, in general, it can be said that there is no important legume adapted to the vast beef cattle areas, and that those which are of value in the dairying districts have a limited application only. A search for a legume of wider adaptability, comparable to the clovers of the south, or a suitable mixture of legumes, must still be regarded as one of the major problems of the north.

Soil Problems. Like the summer-rainfall pastures, the pasture soils of the north are very incompletely understood. The major deficiency appears to be that

of nitrogen which may be overcome by the successful growth of legumes. However, the successful growth of legumes may be itself determined by other soil deficiencies. These are of obvious importance but will not be discussed further here. They must also be studied if the potentialities of the summer-rainfall zone are to be fully developed.

Pasture Management.

The irregularity of the food supply is not only of a seasonal nature. It is also due to the erratic nature of the rainfall and plant growth during the growing season. Native pastures respond quickly to falls of rain, but as quickly deteriorate during subsequent hot dry periods. The same is partly true even of cultivated crops. Under such conditions, the application of standard methods of pasture management, other than merely avoiding over- or under-grazing, has been confused and complicated. The pastoralist, too, especially on large properties, has had to face practical difficulties of watering stock, and fencing. There is scope for the development, by research, of improved systems of management, but their advantage will be fully felt only when pasture mixtures, the nutritive value of which is less dependent upon fluctuations in rainfall, have been developed.

Present systems of management frequently include burning of the accumulated plant debris. This appears to be an attempt to stimulate new growth and improve the protein and mineral relationships of the pasture. This need to burn is itself an indication of the inadequacy of present pastures. It represents a loss of plant food and water, as well as potential animal food, which may not be prevented until more stable and balanced pastures are available.

Conclusion.

The summer rainfall pastures are making a significant contribution to Australia's export trade. This contribution can be materially increased, providing adequate research into their improvement and utilization can be made possible. Given this, a stimulus to the development of northern Australia will be provided which will not only fulfil a national obligation, but will remove at least one source of international jealousy and dissension.

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Production Cost Studies as a Field of Research in Agricultural Economics

By

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In a recent article in this Journal, Roberts[9] attempts to set out the difficulties associated with carrying out cost-of-production investigations and the usefulness of the information which they provide. "We need not concern ourselves here with the *theoretical* objection . . . but will pass on to consider the *practical* difficulties encountered in trying to obtain reliable figures for production costs", says Mr. Roberts (my italics). Surely the most important point in appraising any research project should be the utility of the results obtained rather than the feasibility of methods to achieve those results. The value of a project, if any, lies not in doing it, but in the uses to which it is put after it is done. Viewed from this standpoint, investigations having as their objective the determination of unit production costs of specific agricultural commodities represent misdirected effort, since the results derived therefrom are well-nigh meaningless.

Public Interest.

An ever-increasing demand from farmers' organizations that cost-of-production investigations be undertaken, is evident. The encouragement given by Commonwealth Government Departments to such organizations to produce more factual cost figures in support of claims for price increases and in defence of wage awards, has undoubtedly added to their present insistence. However, there is reasonable doubt whether such studies, if done, would contribute anything towards the solution of these problems. Under such circumstances, the practice, suggested by Roberts, of taking public demand as an index of the urgency and usefulness of various types of economic investigations is of doubtful validity. Given a problem, research workers might be expected, with their knowledge of various approaches and the methods of procedure appropriate thereto, to choose those research tools necessary to throw the greatest light on the problem, rather than that the tools be dictated by outside interests. This criticism is particularly pertinent, where nothing is known by the general public, or administrators, of alternative approaches to the problem.

Admittedly, cost of production or "cost of production plus a profit" has a certain ethical flavour about it. It is inconceivable to the general community that any producer should supply goods to a market which does not return him a price sufficient to cover the outlay incurred in the production of that commodity. The growth of cost accounting technique in the industrial world as a check on efficiency, and the prevalence, in Australia in the early days of the war, of the Government "cost-plus" contract for industrial products, seem to substantiate further the farmer's idea of the validity of this approach, and give him grounds for believing that the Government should guarantee him "cost-plus" on the same basis as industry. However, there are radical differences between agriculture and industry in the organization of the producing unit, in the period of production, in the degree of risk and uncertainty, and in the intricate relationships existing between the processes of production of different products, sufficient to raise the query of the relevance of the cost-accounting technique to agricultural operations.

Overseas Experience.

While modification and improvement of methods of procedure and analysis to suit local requirements are to be commended, this does not imply that the results and experience of overseas research agencies should be overlooked. Thirty years' cumulative experience has led most investigators to question seriously the utility of cost-of-production research. Although many institutions in Britain and America passed through a stage when such studies formed a major part of their research programmes, an insignificant amount of work on commodity production costs was carried on just prior to the present war. In some cases, the " easing out " of this type of study was gradual, and apologies setting out what other useful information was derived from such studies are frequently found in the literature. Whatever useful subsidiary information may have been collected, the point remains that such projects did not achieve any success in the objectives for which they were allegedly undertaken.

It may be said that the history of agricultural economics began with cost-of-production studies. In the United States, from the beginning of the century to the mid-twenties, there was a continuous increase in the volume of cost work. War-time price control and post-war adjustments both gave a great impetus to this type of work. However, it became increasingly evident from 1920 onwards that the idea of using costs as a basis for price fixation was fallacious, and emphasis was placed on their use in farm management work.

After 1925, there was a progressive decline in both the absolute and relative magnitude of this type of research for all purposes. A land-mark in the development of thought on this subject was represented by the appearance of M. K. Bennett's " Farm Cost Studies in the United States "[1]—a sound appraisal of this field of study—in 1928. His conclusions are given in the following passage : " We are now in a position to summarize briefly our conclusions respecting the value of farm cost investigations in the United States. The outstanding facts are that statistics of money costs per unit of product have proved to be less useful than has been supposed for any of the purposes for which they have been collected, and that the considerable effort and expense which have gone into the collection and analysis of such data have largely been ill-spent. Statistics of money costs per unit of product are of negligible value in a program intended to increase farm efficiency ; they contribute next to nothing to the theory of cost-and-price relationships in agriculture ; and they do not provide a sound basis for price-fixing . . . Such data as are of value for farm management purposes are not statistics of money costs per unit of product."

The number of cost-of-production studies declined still further in the early thirties, despite farmers' insistence on the necessity for such work which characteristically reaches a peak in a period of falling prices. At the present time, very few projects of this nature are undertaken in the United States. A few farms working in association with Cornell, Minnesota, and Illinois Universities still keep detailed cost accounts, but their chief value lies in the continuing nature of the projects in relation to subsidiary information collected.

English experience was very similar. Production-cost investigations or " farm costings ", as they are more generally known, date from the beginning of the Great War. The early work of the Agricultural Economics Research Institute at Oxford, which opened in 1913, was largely concerned with the application of cost accounts to agriculture. During the war a Travelling Commission on Production Costs was appointed, and in 1918 an Agricultural Costing Committee was constituted, chiefly to give guidance in price-fixing. Costing studies increased in popularity in the early twenties, but since then they have declined substantially in importance. Immediately prior to the present war, costing was being pursued on very few farms.

In Scotland, farm costing developed parallel to that in England up to 1925. In 1926, a Farm Economics Committee was appointed by the Board of Agriculture

for Scotland to examine and report on various methods of farm accounting in different countries and to recommend the one which seemed best for ascertaining cost of production. In its report,[8] the committee stated that " a great deal of cost accounting has been done in this country in recent years, but it seems difficult to discover whether those who have advocated or followed the practice have asked themselves what exactly they are going to discover by it, or how far the ' costing ' is suitable for the particular material to be submitted to it in the case of agriculture ". After a discussion of difficulties involved, it concluded that ascertainment of production costs was fallacious and futile.

Although various forms of agricultural bookkeeping have been developed to a considerable extent in Europe, more particularly in Denmark, Germany and Switzerland, little of value can be gleaned from the work, owing to the fact that the schemes are designed for the characteristic small-scale peasant farms of these areas. Little analytical dissection of accounts is, however, undertaken, since the basic philosophy of Aereboe, expressed at the beginning of the century, with regard to farm management investigations, is still strongly held. Aereboe[3] stressed the mutual relationship between individual farm enterprises* and discounted cost accounting as a method of approach to the problem of organization. He maintained that the cost of production method is unsatisfactory, insufficient and unscientific, because it dissects the body of the farm in an anatomical manner, and in so doing, kills it for the purpose of real study of economic efficiency.

The Nature of Production Cost Figures.

While it is desired to stress, in particular, the uselessness of cost-of-production statistics in relation to possible objectives, it is pertinent to point out the arbitrary and unsatisfactory nature of the statistics as such. Very briefly, the problem of compilation of costs may be resolved into three sections : (*a*) valuation of expenses, (*b*) allocation of expenses, and (*c*) inclusion of expense items.

Valuation of Expenses.—Arising from the fact that only a small proportion of the total charges made in respect of a crop represent direct out-of-pocket expenses, e.g. seed, fertilizer, spray, etc., it becomes necessary to estimate the expense incurred in using the remaining items. Such items include the allowance to be made for the use of the land, the valuation of the contribution in labour of the farm operator and his family, the allowance to be made in respect of interest and depreciation on capital equipment and the valuation of home-grown foodstuffs and crops used on the farm. The method of valuation of each of these items has been and will continue to be a subject of great controversy in the literature, as there is no objective method of deciding the issue.

Allocation of Expenses.—Since only a small minority of farms produces a single product, it becomes necessary to apportion the overhead charges of the business among the various enterprises, if it is desired to derive the costs expended in respect of each enterprise as distinct from the rest. The whole concept of costing individual crop and livestock enterprises depends on these fundamental prorations, yet they have no firmer basis than personal opinion, and accordingly, their economic and scientific value is negligible. There is a strong body of opinion which holds that profits or losses on individual enterprises do not arise independently of each other and that it may therefore be said that, in general, the individual farm product has no final cost that is determinable independently of the cost of other products. Even in cases where, superficially, some approach to a reasonable basis for allocation is achieved, on closer examination the results can be shown to be highly questionable. For example, in the division of labour expenses, a device frequently used to apportion these costs is the proportionate time spent on jobs which can be definitely recognized

* " Enterprise " is used to indicate the part of a farm business concerned with producing one farm product.

as being directed towards the production of a given commodity. However, it is frequently found that inordinate amounts of time are spent on certain jobs when the pressure of work is not heavy. The enterprise in question, in such circumstances, represents a way of putting in time, which otherwise would be wasted, and its costs are excessively rated.

On the other hand, there is a large group of costs which cannot be allocated on any such basis. This group includes general depreciation and interest on land, expenses for machinery and equipment which are not used specifically for any one crop, time spent on farm improvements, odd jobs and supervision, taxes, insurance, car-running expenses, etc. There is no logical way of apportioning these expenses, although cost-of-production enthusiasts generally manage to split such expenses and conceal their methods. It is sufficient for present purposes to emphasize that the methods are not uniform, and that any method must be a rule-of-thumb procedure, yielding results which could scarcely even be called rough approximations.

The problem becomes more acute still in the case of costs for certain commodities. In agriculture, we commonly have joint products, which do not become differentiated till a late stage in the productive process. The allocation of costs on any sound basis becomes impossible in the case of mutton and wool, poultry and eggs, etc. Procedures used in such cases involve either the treatment of by-products as credits, or the allocation of costs on the basis of percentage receipts from joint products. Either method is highly arbitrary without a solid foundation in logic.

Inclusion of Expense Items.—To add to the general unsatisfactory nature of production costs in agriculture, serious controversy has raged as to whether certain items, often representing substantial items of cost, should be included or deleted from a composite cost figure. Such items are rent of land, interest on investment, and the allowance for management by the operator. It is not proposed to discuss these contentious problems here, but it is necessary to observe that no satisfactory solution or uniformity has ever been achieved.

This brief survey should give some indication of the necessity for accepting with reserve any figures which purport to show the costs of producing individual agricultural products. On account of the diversity of practice, comparable data can seldom be secured from investigations conducted by different institutions or persons. Roberts[9] suggests that "some degree of uniformity in making the unavoidable arbitrary decisions" should be aimed at. But even if this were achieved, it does not mean that the figures derived would be any nearer correct, any less arbitrary, or that they would have any more significance.

The Use of Costs of Production in Price Determination.

There is no doubt that the average Australian farmer's present demand for the derivation of costs of production arises chiefly from his interest in the subject of price and cost relationships. The opinion is commonly held that, in the future, there will be an extension of administrative price-fixing. There is a strong conviction that cost of production represents the only true basis for such fixation. This misconception arises from (*a*) a misunderstanding of the mechanism of price determination, and (*b*) lack of appreciation of the variability of costs in the industry. In regard to the former, suffice it to say that the price of a commodity in a free market tends to be that which, in the long run, will induce production in the quantity required by the market. Such a price may be above or below its cost to the majority of producers in any particular year, and it cannot be determined by reference to the costs of production on any particular farm or on any group of farms, in any one year or over a series of years.

Much space could be used in explaining why cost figures as usually calculated are too high for use in price administration, but most of the reasons can be summed up in the statement that the values assigned to cost factors are well above the prices

at which producers are willing to supply the needed land, labour, equipment and supplies. Partly due to the high proportion of capital sunk in fixed improvements and partly due to an inherent characteristic of the farming community, farmers can and do continue to produce for short and even long periods, while receiving unremunerative returns. They have become habituated in the selling of their labour, management, and even their land, at too low a price.

It is useful in discussing production cost statistics to distinguish between three distinct types of costs which have been termed (*a*) historical costs, (*b*) adequate income costs, and (*c*) necessary costs.[2, 5]

(*a*) *Historical costs* are those based on prices actually paid or prevailing during the production period for labour, power, land and materials used in the production of a given commodity. This is the type of cost figure usually compiled. Charges for the labour of the farmer and his family are usually computed at the prevailing rates for farm labour, and charges for the land usually at prevailing rentals. Thus the composite figure represents what it would cost a farmer to hire all his labour and to rent land for farming.

(*b*) *Adequate income costs* are those which must be realized in prices in order to form incomes that represent a " socially desirable " standard of living. This second meaning of cost of production is cost equal to what prices " should be ", i.e. equal to prices that will support the kind of living producers want, or that somebody thinks they should have. This concept of unit costs is commonly confused with historical costs.

(*c*) *Necessary costs* are those which must be realized in prices if a given volume of production is to be maintained. They are a reflection of the prices which farmers are willing to accept in respect of cost elements. This is the figure in which administrative price-fixing organizations are interested.

There are, of course, certain other characteristics of historical cost figures which severely limit their usefulness as a basis for price determination. Firstly, farm cost investigations are designed to secure information as to the cost of producing a commodity that has already been produced and sold. Due to the wide variability of costs from year to year, such a figure for one year may be no indication at all of the level of costs likely to be incurred in the following year. Secondly, many of the elements commonly included in composite figures are price-determined, not price-determining. Such elements are returns on investment and remuneration for management. Thirdly, there is the general unsatisfactory nature of production costs derived for products produced under joint, supplementary, or complementary relationships with other products.

Since costs, as usually compiled, differ widely from the actual costs at which farmers are willing to produce, any discussion of the adequacy of " average ", " marginal ", or " bulk-line " historical costs as a basis for price fixation is unnecessary. Similarly, discussion of the sampling technique to be used in cost investigations is equally irrelevant. The use of a less questionable method of sampling will not improve figures which are fundamentally erroneous. Reasonable doubt exists as to whether it will ever be possible to make computed costs coincide with actual costs.[6]

The determination of necessary costs is a difficult problem. What is required is some indication of the price necessary to bring forward a given supply. This can be achieved, in some degree, by ascertaining by budget analysis what shifts in production a representative sample of farmers can advantageously make, assuming that the price of the product concerned and those of competing products are set at various levels. Provision would have to be made for (*a*) a different response to guaranteed, as compared with open market, prices, (*b*) changing economic conditions, (*c*) the time within which the supply was required. Under war-time conditions, the method adopted is likely to be a trial-and-error procedure—a matter of fixing a price and being guided by the supply forthcoming.

Although historical unit costs of production fail to provide a workable basis for the fixation of agricultural prices, this does not mean that changing cost and price relationships can be disregarded. Temporary disturbances in such relationships caused by special circumstances are best overlooked, but any trends in costs and changes to new levels, which are likely to persist, must be taken into account in any administrative price-fixing programme. The best way to keep watch on such changing costs is by a comparison of index numbers of quantities of expense items used in given regions combined with the index numbers of the prices paid for them.[4, 7]

The Use of Costs of Production for Farm Management Purposes.

Although the aforementioned objective is the major interest at present, it is often implied that a knowledge of production costs would also be valuable as a guide to the improvement of the efficiency of the farm. This objective of cost studies tends to assume ascendancy when the impossibility of achieving the first objective is realized. Accordingly, it is important that the limitations of unit commodity costs in this connection should also be stressed.

The most prevailing misconception is that unit costs of production can reveal the best choice and combination of enterprises that should be used on the individual farm. According to this view, the relative profitableness of crops is judged by a comparison of unit costs with prices received, and this is supposed to be an indication of the degree to which the respective crop or livestock enterprises should be expanded or contracted. In practice, the use of costs of production for this purpose has proved to be highly misleading.

This state of affairs arises out of a fundamental characteristic of agricultural organization, namely that there are relatively few enterprises which are conducted in isolation on individual farms. In other words, there are few enterprises which are not inextricably involved in supplementary, complementary, or joint-product relationships with other enterprises.

Analytical cost-accounting attempts to break these relationships when costs are allocated on various arbitrary bases to produce a composite unit cost figure. Such figures nearly always show supplementary enterprises either carried on at a loss or at a relatively low profit, even in circumstances where the curtailment of the enterprise in question would reduce the net income of the farm business. Even ideal figures, although showing the relative profitableness of enterprises, could not indicate whether expansion or contraction of individual enterprises was merited. It is possible that a loss or low profit in respect of an enterprise may have resulted from it being insufficiently expanded, in which case, to follow the obvious course and abandon the enterprise would be absurd.

The effect of changes in farm organization cannot be measured by the return from one crop or livestock enterprise, but must be examined from the standpoint of the farm as a whole. The method of budgeting provides a means of determining suitable enterprise combinations from this standpoint, in so far as a knowledge of future trends in costs and prices permits. It is a more direct and easily understandable approach to the problem, and does not necessitate the violation of commonsense principles.

An idea is also prevalent that studies on specific production costs can provide some guidance as to the comparative advantage of conducting specific enterprises in various districts. In actual fact, such costs are no basis for any study of interregional competition. Apart from the fact that the demand side of the picture is overlooked completely, the serious objection arises that the operation of the principles of comparative advantage is profoundly affected in agriculture by the presence of supplementary, complementary and joint-product relationships between enterprises. The effect of these relationships is that the advantage compared is not characteristically between individual products but between the different combinations of

enterprises in which these products are included. Thus, a comparison may be made between a district where 25 per cent. of the farm area is devoted to a certain crop and a district where 75 per cent. of the area is planted down to that crop. What determines whether a crop shall be grown in a given area is not the costs of growing that crop in that area relative to costs in other areas, but rather whether the crop in question forms part of a combination of enterprises, which represents the most profitable system of farming which can be carried on in that area.

Unit production cost data are therefore valueless as guides in determining what enterprises to combine and in what proportions they should be combined. They have severe limitations as indices of the efficient operation of farm enterprises and are no basis for a study of interregional competition in agriculture.

Conclusion.

In the above remarks, an attempt has been made to outline briefly some of the major limitations of cost-of-production studies. It is not, by any means, an exhaustive examination of the problem, but stress has been laid on those phases which appear most pertinent in the light of recent discussions. However, it should be clear that research having as its objective the determination of production costs is of little value for any purpose. It is true that we badly need the basic economic facts concerning Australian rural industries, but we want those of a type that can be used.

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TECHNICAL NOTE

THE EFFECT OF THE HOST FRUIT UPON THE SCALE *AONIDIELLA AURANTII* MASK. IN RELATION TO ITS PARASITE *COMPERIELLA BIFASCIATA* HOW.

In their efforts to control the red scale of citrus, *Aonidiella aurantii* Mask., in California by biological methods, some interesting facts have come to light in regard to the relationship between its parasite *Comperiella bifasciata* How. and the host plant upon which its own host, *A. aurantii*, develops. These have been fully recorded by H. S. Smith (J. Econ. Ent., 35 : 809, 1942) and can be briefly summarized as follows :

(1) That *Comperiella bifasciata* of China breeds freely upon *A. aurantii* when this is reared upon citrus, but is unable to do so when the scale is grown upon *Cycas*.

(2) That the morphologically identical *Comperiella bifasciata* of Japan breeds freely upon *A. citrina* Coq., morphologically almost indistinguishable from *A. aurantii*, but is unable to breed upon this latter species although the Chinese and Japanese *Comperiella* interbreed freely.

In January, 1943, the writer received, through the good offices of the Council for Scientific and Industrial Research, a colony of the Chinese *aurantii* parasitizing form of *Comperiella*, and in the course of breeding these some observations were made which may prove of interest.

Experimental.

Two methods of breeding the parasite were adopted :

(1) Scale-infected citrus trees of various species grown in pots and placed in large cages. This method gave excellent results, apparently regardless of whether orange, citron or lemon was used.

(2) Upon scale-infected fruits placed in glass battery jars and kept in an incubator at about 72° F.

Using the latter method with lemons as host fruit it was soon realized that yields were disappointing, which suggested, in view of the facts enumerated above, that the host fruit might have some bearing, and tests carried out as shown below suggest that this may be so.

(1) Equal numbers of females were placed in jars containing either oranges or lemons and records kept of the survivors after two weeks, also of yields, sexes, etc., as shown in the following table.

No. of females.	Survival.		Yields.		Yield per female.	
	Oranges.	Lemons.	Oranges.	Lemons.	Oranges.	Lemons.
9	9	5	137	58	15·2	6·5
12	9	1	237	80	19·7	6·5
7	4	3	60	32	8·6	4·6
9	5	3	48	21	5·4	2·4
9	5	3	44	19	4·9	2·4
8	7	1	48	29	6·0	3·6
8	4	2	116	37	14·5	4·6

This shows that of the sixty-two females used in each case, forty-three survived two weeks on the oranges as compared to only eighteen on the lemons, whilst the yield in the resulting generation averaged 11·5 from the oranges as compared to 4·4 from the lemons, with a maximum of 19·7 from the oranges compared with a maximum of 6·5 from the lemons.

(2) Tests were then carried out to see whether the parasites exercised any selective tendency when they had choice of either scale-infected oranges or lemons. These tests indicated that such was the case. In the first trials no record was kept of the numbers of parent females used but only of the resulting yields. These were

most striking, 229 being bred from the oranges as compared to only 22 from the lemons.

With the advance of winter much difficulty was experienced in obtaining comparable fruit—first sooty mould on the oranges almost, or completely, inhibited the development of the parasite on this fruit and then the maturity of the fruit led to its breakdown prior to emergence of the parasites.

None the less, the results continued to support the previous observations, the maximum yield obtained from lemons, where the parasite had the choice of either fruit, being 3·3, whilst the oranges yielded up to 13·6. Where, however, the parasite was given one host fruit only the subsequent maximum yields were 11·6 and 6·8 for oranges and lemons respectively. Owing to the early breakdown of the seasonal ripening of oranges, the yields from this host fruit fluctuated greatly, several collapsing before any emergences took place, which occurred only once with the lemons during the period under review. Taking the whole series into account where they were given oranges or lemons exclusively the yields were 6·4 and 3·3 per female for oranges and lemons respectively, whilst in the series where they had choice of host fruit and *including* all cases where fruits had collapsed up to the end of November, the yields were 5·1 for oranges as compared to 1·5 for lemons.

The above figures seem to indicate that, in some way, lemon, as a host fruit for *A. aurantii* has an inhibiting effect upon the development of its parasite, *C. bifasciata*, although it is hard to suggest in what way. Resulting parasites were just as large from lemon as from oranges, whilst length of developmental period was no longer. As the female appears to feed upon the juices exuded by the scale after puncturing, this may have some effect on either its fertility or vitality, as suggested by the greater survival percentages from oranges, although in all cases a honey jelly was supplied as additional food.

HUBERT W. SIMMONDS.

Waite Agricultural Research Institute,
Adelaide, S.A.

(Received for publication, 8th February, 1944.)

The Australian Institute of Agricultural Science

MEETING OF COUNCIL.

A meeting of Council was held at the Department of Agriculture, Melbourne, on the 17th January, 1944. *Present.*—Mr. J. A. Aird (V.), in chair, Dr. H. C. Forster (W.A.), Mr. F. S. Crawford (T.), and the Honorary Secretary, Mr. A. J. Vasey. Apologies were received from Dr. A. E. V. Richardson (S.A.), Mr. R. W. Prunster (A.C.T.), Mr. G. H. Vasey (N.S.W.), Mr. J. L. Provan (Q.), the Hon. Treasurer, Mr. R. L. Twentyman, and the Assist. Hon. Secretary, Mr. R. D. Croll. Principal's instructions had been forwarded by each of the absent proxies.

The following applicants, details of whose qualifications had been approved by the Qualifications Committee, were admitted to corporate membership: Messrs. A. C. Orman and J. V. Skipton (N.S.W.), D. B. Williams, R. G. Thomas and V. D. B. Skerman (Vic.); W. J. Bettenay, A. J. T. Marshall, N. R. McKeown (W.A.); J. G. Crawford (A.C.T.); and P. G. Schinkel (S.A.). The following were admitted to student membership: Messrs. C. L. Bangs, R. B. A. Bettenay, F. V. Bridgman, D. K. Giles, R. P. Joaquim and E. R. Watson (W.A.). The transfers of Messrs. K. N. Northcote from the Victorian to South Australian Branch, and N. H. White from A.C.T. to Tasmanian Branch were recorded.

The following office-bearers were appointed for 1944: Hon. Treasurer, Mr. R. L. Twentyman; Hon. Secretary, Mr. A. J. Vasey; Editor of Journal, Dr. F. T. Bowman; Business Manager of Journal, Dr. N. S. Noble; Publications Committee, Dr. H. J. Hynes (Chairman), Dr. E. T. Edwards, Dr. I. A. Watson and Mr. W. Poggendorff, together with Editor and Business Manager; Qualifications Committee, Professor J. A. Prescott (Convener), Dr. A. R. Callaghan and Mr. Rowland Hill; Hon. Assistant Secretary, Mr. F. S. Crawford was appointed in place of Mr. R. D. Croll, resigned.

At the request of the New South Wales Branch, a letter was addressed to the Australian Broadcasting Commission, in regard to its advertisement calling for applications for an Agricultural Editor to the Commission, stressing the value of a basic scientific training for this position.

MEETINGS OF BRANCHES.

New South Wales Branch.

The ninth annual general meeting of the N.S.W. Branch was held at Science House, Sydney, on the 11th February, 1944. The election of office-bearers for 1944 resulted as follows : President, Mr. R. H. Anderson ; Vice-President, Dr. E. T. Edwards ; Hon. Secretary, Mr. K. O. Campbell ; Hon. Treasurer, Mr. N. Lloyd ; Members of Management Committee, Miss H. Wrigley, Messrs. J. M. Vincent and B. Gardiner. Mr. H. P. Brown was reappointed Journal Sub-Editor. Members of the Scientific (Agricultural) Advisory Manpower Committee were reappointed except Dr. H. J. Hynes, who had tendered his resignation and whose place was taken by the election of Mr. G. de Val Davis.

Mr. W. H. Pawley, Convener of the Branch Sub-Committee on Rural Reconstruction, briefly outlined the work accomplished. The report, which has been forwarded to the Rural Reconstruction Commission, will appear in a subsequent issue of the Journal.

The main business of the evening was the address of the Retiring President, entitled " The Food Position ", which appears in this issue of the Journal.

Queensland Branch.

Mr. J. F. Kennedy, formerly a member of the Pastoral Research Branch of the Australian Estates Company, addressed the Queensland Branch in November, 1943, on the subject of supplementary feeding of sheep in western Queensland. When the investigation work on this problem was commenced in 1935 there was no scientific basis for many sheep husbandry practices. An attempt was made at Elderslie, near Winton, to ascertain the chemical composition of the pasturage eaten by the sheep, but the sampling methods were inadequate. Rumen analyses were attempted, but it was not possible to identify much of what had been eaten.

A phosphate lick trial was then carried out at Manuka, near Winton. This revealed that there was no significant difference in body weight, in wool production, or in rate of growth of the lambs dropped, attributable to phosphate licks ; nor was the concentration of inorganic phosphorus in the blood affected by licks.

Whilst it was probably true that the natural diet was deficient in phosphorus, it was not recognized widely that nitrogen was also deficient and that a supplementary ration of phosphate alone was insufficient. The investigators then tackled the problem of devising a suitable protein lick and developed a product of bloodmeal and molasses containing 25 per cent. protein.

South Australian Branch.

On 20th December, 1943, a general meeting of the Branch was addressed by Dr. A. R. Callaghan on the subject " Some Experiences on the Food Front ".

Victorian Branch.

Branch members attended a meeting of the Melbourne University Agricultural Society on 19th November, 1943, when an illustrated lecture entitled " Hunger in Plants " was given by Mr. C. R. Millikan. After enumerating the elements known to be essential for plant growth, the lecturer discussed some of the causes of malnutrition in plants, the principles underlying the diagnosis of symptoms and the various control measures available. One point stressed was the need for more information on the seasonal variations in availability of minerals. An example of this was zinc deficiency in flax. A crop might show very severe symptoms of zinc deficiency in the winter and yet make normal growth in the spring.

The symptoms of deficiencies of individual elements were described and illustrated and conditions associated with the occurrence of the particular deficiency were discussed. Calcium deficiency was of interest due to the occurrence in Victorian flax crops of a disease known as " withertop ", due to this cause. Withertop was due to a temporary deficiency of calcium induced by excess of soil moisture during the stage of rapid elongation of the flax plant. Its complete control in the field by application of lime had been but recently demonstrated. Magnesium deficiency or " sand drown " was also aggravated by excessive rainfall, while " drought spot " and " heart rot " caused by boron deficiency were most marked in dry weather.

There are large differences in the normal requirement for specific minerals exhibited by different species of plants. Some species or varieties have the capacity of absorbing more of a given mineral from a deficient soil than do other plants, for example, rye may make normal growth on a soil in which oats show severe symptoms of " reclamation " disease due to copper deficiency.

Correspondence

Invention of the Stripper.

In his article " Centenary of the Invention of the Stripper ", published in the September, 1943, issue of the Journal, Mr. W. J. Spafford pays a tribute to " John Ridley, the man who invented, constructed and developed commercially the ' Stripper ' ". Everyone must recognize the importance of the stripper to Australian agriculture and indeed also to wheat-growing in other parts of the world, and can and should agree that John Ridley is entitled to great credit for his outstanding contribution in constructing and developing commercially the early strippers, but the claim made that he was the inventor cannot be conceded.

In the *Journal of the Department of Agriculture of Western Australia*, Volume 14 (second series), 193-247, 1937, I published the result of a search from July, 1936, to August, 1937, of available publications and documents relating to the invention and construction of the first stripper. Full details are given in this article together with copies of 82 relevant references as appendices. From the evidence collected I could only conclude that the inventor of the stripper was John Wrathall Bull, who at the historic meetings held in Adelaide on September 19th, 20th and 21st, 1843, exhibited a model which embodied the unique principle of " the comb and beaters " which is the essential and distinctive feature of the stripper.

Apparently Mr. Spafford has not read the article referred to and is not familiar with the whole of the available evidence. If he were, it is inconceivable that he would have taken as the basis of his statement an extract from an impassioned *ex-parte* editorial published not on 19th November, 1845, as stated, but on 21st March of that year. From a recent enquiry made, on my behalf, at the South Australian Archives, it is also learnt that no issue of the *Southern Australian* appeared on 19th November. The full text of the editorial, from which Mr. Spafford has quoted an extract, was given by me as Appendix 49, and comments relating thereto are on pages 203-205 of the letterpress.

Bull challenged the editorial opinion that Ridley was the inventor of the stripper in a letter which appeared in the *Observer* on 5th April, 1845, and then offered to submit evidence to support his claim that he (Bull) was the inventor of the stripper, provided Ridley endorsed the opinions put forward in the editorial. It is significant that Ridley failed to do this.

It is conceded that the editor of the *Southern Australian*, in common with many contemporaries, was sincere in his belief that Ridley did invent the stripper. It is my opinion that this belief arose from a failure to distinguish between the inventor of the principle and the maker who applied that principle in the construction of the first machine.

As the result of the investigations in 1936 and 1937 the matter was summed up thus : " Bull by originating the principle of the " comb and beaters " and Ridley by the application of that principle rendered conspicuous service to South Australian agriculture and later to Australian agriculture. The two men are therefore entitled to share jointly in the honour which is fully merited by that service, the importance of which to Australian agriculture can hardly be exaggerated."

G. L. Sutton.

Mt. Lawley, W.A.,
20th November, 1943.

Milking Machines on Dairy Farms.

In the lecture " Science and a Better Way of Life for Farmers ", by Dr. S. L. Macindoe, published in the September issue of the Journal, the following statement was made : " That barely twenty per cent. of our dairy farmers use milking machines is further evidence of a lag between technical progress and practices." This seems to me to be a reflection on the actual dairymen of the Commonwealth, certainly of Victoria. In my opinion an agriculturist should not be classed as a dairyman unless he has over thirty cows. With less than this number he usually has some other form of income. In Victoria the number of herds over thirty cows is 10,706, and the number of milking machines installed is 10,221. No doubt some of these machines are used on herds of less than 30 cows, but allowing for this, the percentage would be well over eighty per cent.

Assuming a minimum of twenty cows for a dairyman, there are 15,536 herds of over this number, and the percentage of these with machines is, therefore, sixty-six per cent.

Even including all herds down to five cows, the percentage for Victoria does not fall to twenty, as there are 33,532 herds of over five cows, and the percentage of these with machines would be thirty per cent.

I regret that I have not the figures for other States on hand, but surely they are not so backward as to reduce the percentage figures for the Commonwealth to that stated by Dr. Macindoe.

J. A. AIRD.

State Rivers and Water Supply Commission, Melbourne,
26th November, 1943.

It will be noted that the statement " that barely twenty per cent. of our dairy farmers use milking machines " occurs in the same paragraph with and follows directly on a reference to the New South Wales Government dairy mechanization scheme. It might well be understood therefore that the figure stated refers to those for the State of New South Wales only.

Figures taken from the N.S.W. State Statistician's records for 1940-41 show a total of 4,032 milking machines and 20,688 registered dairies. The percentage of 19·5 per cent. registered dairies using machines is therefore an upper limit, since it is assumed for purposes of computation that only one machine is used per holding.

Further, a statistical survey of selected N.S.W. North Coast police patrol districts for the twelve months ending 31st March, 1941, indicated that in seven important dairying zones in New South Wales the percentage of registered dairies having milking machines varied between five and thirty per cent., the average number of " milkers " (in milk and dry) per registered dairy in the same zones varying between 40·6 and 50·6.

S. L. MACINDOE.

Department of Agriculture, Sydney,
3rd December, 1943.

Book Review

BACTERIAL SPOILAGE OF FORTIFIED WINES, by J. C. M. Fornachon.

(Pp. ix+126, with 4 plates. Australian Wine Board, Adelaide. 1943. Price 5s.)

Wine spoilage due to the development of bacteria has been only too common a cause of serious loss to wine makers since the early days of the Australian wine industry. As is explained in the introductory chapter, European research during the past eighty years was limited to unfortified wines, those containing alcohol to a standard of 30 per cent. proof or over being generally regarded as immune from bacterial attack ; yet during the past twenty years bacterial spoilage of fortified wines containing 35 to 37 per cent. of proof spirit has been reported in southern Europe, South Africa, California and Australia. Owing to the seriousness of the trouble the Australian Wine Board, in June, 1934, sought the assistance of the Adelaide University in the investigation of the whole question of wine diseases with a view to their prevention and cure, as a result of which Mr. J. C. M. Fornachon was appointed to make investigations. He began his work in November, 1934, at the Adelaide University, later removed to the Waite Agricultural Research Institute, and in 1938 visited America and Europe, returning by way of South Africa. He spent eleven months at the University of California, after which Europe was visited, but owing to the outbreak of war he was hurriedly recalled to Australia.

The book reviews the results of investigations extending over the period of several years and is divided into two parts. Part I details the difference between " tourne " of European table wines and the spoilage of fortified wines, indicating the important part played by bacteria of the Lactobacillus genus, which are considered under five different groups or types. Chapters follow that deal further with spoilage and its causative bacteria, the factors affecting it and its control. Part II, after describing methods of analysis, treats in greater detail the nature and cause of spoilage in fortified wines, the influence of various factors, such as nitrogen, alcohol, sulphur dioxide, tannin and other substances on bacterial growth, the heat resistance of bacteria and their control by acidity. The vital importance of accessory growth substances, such as those deriving from autolysed yeast in favouring bacterial growth is dealt with at considerable length.

Photomicrographs reproduced at the end of the book illustrate the morphological characteristics of the five different groups of Lactobacillus at a magnification of ×1,000.

This very informative work will be welcomed by Australian oenologists. No cellar or winery library should be without a copy. As Herbert Kay, President of the Wine Board, says in the foreword, quoting the public statement of one of South Australia's best wine makers, " If the Wine Board had done nothing but the investigation into the spoilation of wines, it would have more than justified its existence."

FRANÇOIS DE CASTELLA.

Current Notes and News

Report of the N.S.W. Council of Primary Producers' Associations on Rural Reconstruction.

This 14-page roneoed statement of producer views was presented to the Rural Reconstruction Commission during its September sittings in Sydney, and copies are available from the Hon. Secretary of the Council, Department of Agriculture, Sydney. Constituents of the Council include the Agricultural Bureau, Farmers and Settlers' Association, Wheatgrowers' Union, Stud Pig Breeders' Association, Vegetable Growers' Association, Potato Growers' Association, and the M.I.A. Rice Growers' Association.

The report examines the possibilities of post-war markets and as a result states that " we have to examine every possible means to achieve lower costs of producing, handling and marketing our primary produce. This is essential, not only to the welfare of the primary producers, but to the entire national economic fabric. It becomes a national responsibility . . . The implication is that our agriculture must be nationally planned, with full cooperation between the individual, the State and the Commonwealth."

The emphasis throughout the report is on increased efficiency, which may be achieved through measures amenable to planning. These measures include planned reduction of the debt fabric which contributes so much to high costs of primary production, planned production, marketing, restoration and conservation of soil fertility and productive capacity, and conservation and development of such resources as water. In addition, however, the report covers many sectionalized topics such as Farmer Cooperative Societies, Commodity Marketing Boards, developments to increase home consumption, closer settlement, reconstruction of marginal or depressed rural areas, absorption of members of the Forces, decentralization of agricultural research and demonstration units, crop insurance, local committees for the organization of production and conservation, improved amenities in rural life to arrest the drift of the land.

Dealing with restriction of capital indebtedness, much of which has been incurred in the period of rural depression which has extended over much of the interval between the two wars, the report avers that this would make one of the most direct and greatest single contributions to lowered production costs. " It is indisputable that money, that should be going back into the farms to increase fertility and general efficiency of production, disappears in continual and seemingly endless interest payments." A Mass Conversion Loan, underwritten if not wholly taken over by the Government, is suggested as an orthodox technique of handling the problem. This infers a gathering in of total rural indebtedness to a central source of credit, a uniformly low rate of interest possibly amounting to an indirect form of subsidy, and thereafter supervision over all mortgaging or borrowings.

On the subject of orderly production, the report contends that another great contribution to lower costs of production may be had from planned production as against the individual " hit or miss ", " traditional " or " what you will " goals of the past. The report does not favour compulsory direction of production. It refers to the U.S.A. programmes in which economic privileges for those who cooperate in the national acreage goals help to assure adequate voluntary cooperation between farmer and national plan. The Australian rice industry is quoted as an instance of the amenability of an Australian production to intelligent planning.

In regard to planned restoration and conservation of soil fertility, the report suggests national conservation payments to farmers carrying out an annual programme (approved by the local committee) of agricultural conservation measures. It contends that most farmers are willing to cooperate in practices to conserve, but " the majority are necessarily so engrossed with the need to farm for an immediate return that the conservation practices appear almost a luxury and in any case beyond their immediate means to finance ". The suggested conservation payments, by helping to provide the cash means with which to finance the practices, would be an immediate stimulus to better farming or, in other words, increased productive efficiency. " As in the American programme, the price adjustments for cooperators in acreage allotments of soil-depleting, marketable commodities could be tied with a farm-conservation programme and conservation payments." The possible cost of such national conservation payments is discussed in a relative way.

In its treatment of planned marketing, the report interestingly suggests commodity marketing boards along the lines of a cooperative society, the boards being producer-controlled on an elective basis but with provision for Government nominees and, more particularly in the case of commodities mostly for home market, for appointment of consumer representatives. Organized marketing is stated to be complementary to orderly, planned production ; " the prospects of properly planning production would not be bright in the absence of organized marketing ". Again the rice industry is quoted, for its stabilization of production in direct relation to reliable markets. The necessity for representatives in all countries which may be likely consumers of our products is stressed.

Obituary

HENRY TRYON.

The late Mr. Henry Tryon, who died in Brisbane in November last at the age of 87, was for many years an outstanding figure in Australian scientific circles. For about 30 years he was Chief Entomologist and Plant Pathologist in the Queensland Department of Agriculture and Stock and during that period published extensively on entomology, plant pathology, botany and animal parasitology. In 1895 Mr. Tryon was sent to New Guinea to collect sugar cane varieties and amongst other varieties brought back " Badila ", one of the best canes ever introduced to Queensland. He was a member of the Travelling Commission which visited several overseas countries in 1912-13 to investigate the possibility of biological control of Australian prickly-pears, and was also a member of the Commonwealth Commission on Cattle Tick Control.

Personal Notes

Captain S. L. Allman was mentioned in despatches in December last among those who have rendered gallant and distinguished service in the South-west Pacific Area.

Flight-Lieutenant W. A. Horsley (R.A.A.F.) has been posted missing from air operations in the Middle East and is now believed to be a prisoner-of-war in Germany.

Mr. J. A. Weddell has been released from the Army for entomological work in the Queensland Department of Agriculture and Stock.

Dr. L. J. H. Teakle was elected President of the Western Australian Branch of the Australian Chemical Institute at the annual meeting last year.

Mr. J. K. Taylor has been appointed Deputy Chief of the C.S.I.R. Division of Soils. Mr. C. G. Stephens has been appointed Senior Research Officer in charge of the section of Soil Survey. Dr. T. J. Marshall has been appointed Senior Research Officer in charge of the section of Soil Mechanics. Mr. G. D. Hubble has been transferred to Hobart to take charge of the regional headquarters of the C.S.I.R. Division of Soils there.

The staff of the Council for Scientific and Industrial Research, Division of Soils, which has its headquarters at the Waite Institute, has recently been augmented by the appointment of four Assistant Research Officers to undertake work in connection with soil survey. They are Messrs. K. H. Northcote, B.Agr.Sc., J. H. Shepherd, B.Sc., R. C. Sprigg, B.Sc., and G. A. Stewart, B.Agr.Sc. Messrs. N. J. Flentje, B.Agr.Sc., and B. S. Janes, B.Sc., have been appointed Research Assistants in the Plant Pathology Department of the Waite Institute.

Messrs. A. A. Ross and N. H. Shaw are the joint authors of a report entitled " Dust Hazards in Australian Foundries ", which is published as Technical Report No. 1 of the Industrial Welfare Division of the Department of Labour and National Service, Melbourne, and is stated to be the first Australian contribution to this subject.

Mr. J. M. Vincent has returned to full-time duties as Lecturer in Bacteriology and Biochemistry in the Faculty of Agriculture, University of Sydney.

Mr. W. Wallace Jones has been appointed Deputy Headmaster, Yanco Agricultural High School, N.S.W.

Warrant Officer R. D. Wilson (A.I.F.) attended the annual general meeting of the N.S.W. Branch in February, whilst on leave from Radio Location duties in the north.

Mr. W. J. Webb has been transferred from the Sydney to the Melbourne office of I.C.I.A.N.Z. in the Agricultural Chemicals section.

Dr. C. J. Magee was the senior member of a Scientific Mission which was recently sent by the Scientific Liaison Bureau in cooperation with the Services, to make a survey of the conditions of Service Materiel under tropical conditions in New Guinea. The confidential report of the Mission has been issued and widely circulated in the Services.

In the New South Wales Department of Agriculture Mr. A. W. S. Moodie has been appointed Chief Instructor, Division of Plant Industry. Prior to this appointment, Mr. Moodie was Senior Agrostologist for a number of years and, more recently, was Fertilizer Rationing Officer. Mr. Lewis McLennan has been released from the A.I.F. after active service, and has taken up duties in the Inverell district. Mr. H. Bartlett was appointed State Controller of Agricultural Machinery for N.S.W., towards the end of last year. During Mr. Bartlett's absence on this work, Dr. S. L. Macindoe is acting as cereal specialist. Dr. E. T. Edwards has resumed full-time duties in the Biological Branch, after a lengthy period with the Division of Plant Industry. Dr. F. T. Bowman recently received promotion to the position of Special Fruit Research Officer.

Mr. F. C. McCleery has returned to the N.S.W. Department of Agriculture after a lengthy period of work on quality control in munitions in Victoria.

Mr. W. S. Sutton, who was engaged on work with the Blood Bank during the greater part of last year, is now Executive Officer, Food Technology Section, Commonwealth Food Control, and has charge of a Sydney laboratory for examining Defence foodstuffs.